Engineering News

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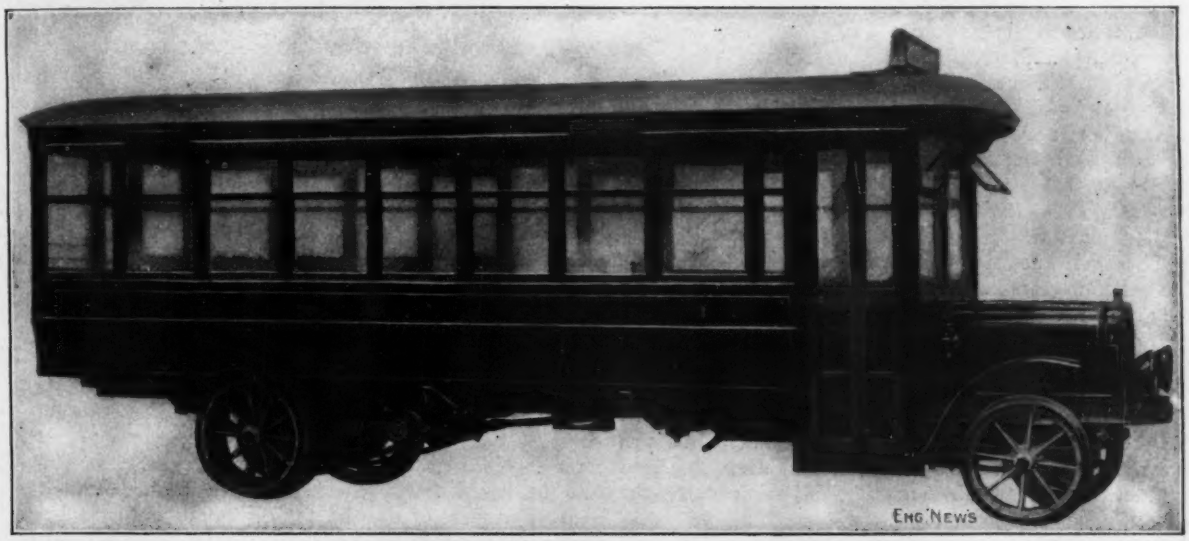
A 34-Passenger Single-Deck Motor Omnibus

Eight large single-deck omnibuses of the type shown in the accompanying figures have recently been built for the Pittsburgh Auto Transit Co., which has started a transportation service through certain better residential streets of that city. The routes selected are on wide and well paved streets.



Perhaps the most notable feature of the new busses is the large seating capacity for a single-deck vehicle. This is secured by using longer and wider bodies than have before been built for such service in this country. A second feature is the operation of each bus as a prepayment vehicle with only one employee. A single doorway is used forward directly opposite the chauffeur's seat and controlled by a hand lever at his left hand. There is an emergency exit in the rear of the car controlled by the chauffeur and having in front of it a portable seat. Backed up against the chauffeur's seat is an ordinary cross seat. Just back of the door is a longitudinal seat and this is protected from the interference of boarding or alighting passengers by a wooden partition and pipe stanchions. Passengers signal for stops by push buttons located in the window casing frames.

A 34-Passenger Single-Deck Motor Omnibus

Many features of similarity to light street cars are seen in the body construction. For instance, the lightweight windows have the upper sashes set in a single frame extending from end to end of the body, materially stiffening the construction. The lower sashes can be raised to their full height.

The under-frames of these omnibus bodies have, as usual in such vehicles, the crossings as the principal carrying members. However, on account of the length and width, it was found advisable to bolt heavy forged angles to the underside of the chassis frame, bent up and attached to the side sills as shown in Fig. 1. The chassis is a five-ton motor-truck type manufactured by the White Co., of Cleveland. The body was built by the J. G. Brill Co., of Philadelphia. The following principal dimensions may be noted.

Length of body	23 ft. 0½ in.	Street to first step	14 in.
Centers of side posts	2 ft. 4½ in.	First to second step	11 in.
Width over sills	7 ft. 7 in.	Second step to floor	11 in.
Width over posts (rear)	8 ft. 0 in.	Wheel base	19 ft. 1 in.
Width over posts (front)	7 ft. 0 in.	Diameter of wheels: front	36 in.; rear 40 in.
Extreme width	8 ft. 2½ in.		
From pavement to side sills	2 ft. 9 in.	Weight of chassis	8,500 lb.
From side sills over roof	7 ft. 5 in.	Weight of body	5,100 lb.
From floor to center of headlining	6 ft. 10½ in.	Total weight	13,600 lb.

The Covering of Jones' Falls, Baltimore, Md.

SYNOPSIS—An open creek, taking the drainage of a city's streets and houses and long notorious as a public nuisance, is now being covered as a part of the new sewerage construction in the city of Baltimore. In addition the cover is to be used as a low-grade street connecting railway stations and the wharves, which are now connected only by heavy grade streets.

Jones' Falls is a small stream with a low normal flow but with an estimated storm-flow of 15,000 cu.ft. per sec., which drains an area of about 55 sq.mi. north of the city of Baltimore and passes practically through the business center of the city to its mouth in Baltimore harbor. Early in the history of the city its very favorable location led to its use as a drain through which all storm-water and, as time went on, considerable house sewage was led to the Bay. As a natural result of this use it developed soon into an open sewer, filthy and foul smelling. Its nuisance was augmented by the fact that its mouth is several feet below the tide level in the harbor, so that there was backwater extending up several blocks into the city and forming an open cesspool where matter putrified.

As is well known, the city of Baltimore up to within the past few years had practically no sanitary sewers and only an incomplete storm-sewer system. House sewage was passed either into cesspools under the individual houses or to private sewers built indiscriminately in the street and leading as best they might to the nearest water courses, the principal one of which was Jones' Falls. Street drainage in the drainage area of the Falls was led to it directly, in some cases so far below the flood level of the stream that in times of high water the streets some distance away were flooded by the backflow.

Some years ago about $2,000,000 was expended in improving the regimen of the Falls. This work consisted primarily in the construction of masonry retaining walls on either side of the Falls, built snug up against the adjacent buildings where there were any and backed by grass surcharged slopes where there was no building. The bottom was left in the natural rocky state with numerous falls of more or less size. At low water the natural flow is hardly appreciable, although house and street drainage always added somewhat to this amount. At high water, however, the flood stage frequently reached back into the city streets, with consequent damage.

In 1905 the Baltimore Sewerage Commission started work on the construction of a complete sewerage system for the city. One of the first steps taken toward this end

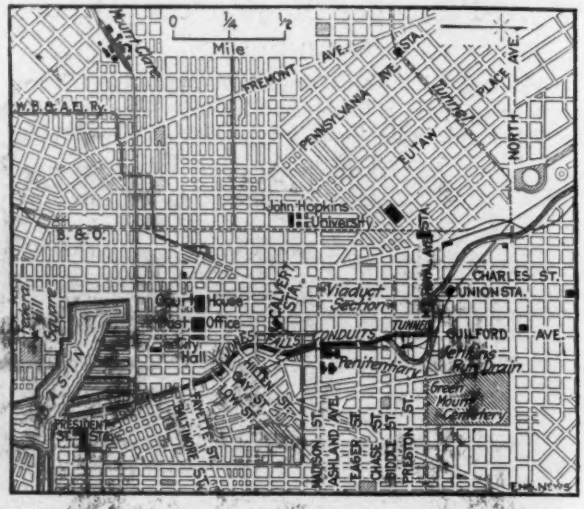


FIG. 1. MAP OF PORTION OF BALTIMORE, MD., SHOWING LOCATION OF JONES' FALLS AND THE COVERED PORTION THEREOF

was the construction of intercepting storm water drains in the low districts to carry surface drainage into the harbor in place of allowing it to enter the Falls, and sewers paralleling Jones' Falls and taking therefrom all of the sewage which had hitherto entered the Falls. These interceptor sewers led to mains which eventually reached the sewage-purification plant in the Back River district of the city. This relieved the Falls of its main source of pollution, but left it an open water course through the city, subject to the many sources of pollution which would tend to contaminate it. Partly to relieve this offensive condition and partly to provide a new and very necessary road-

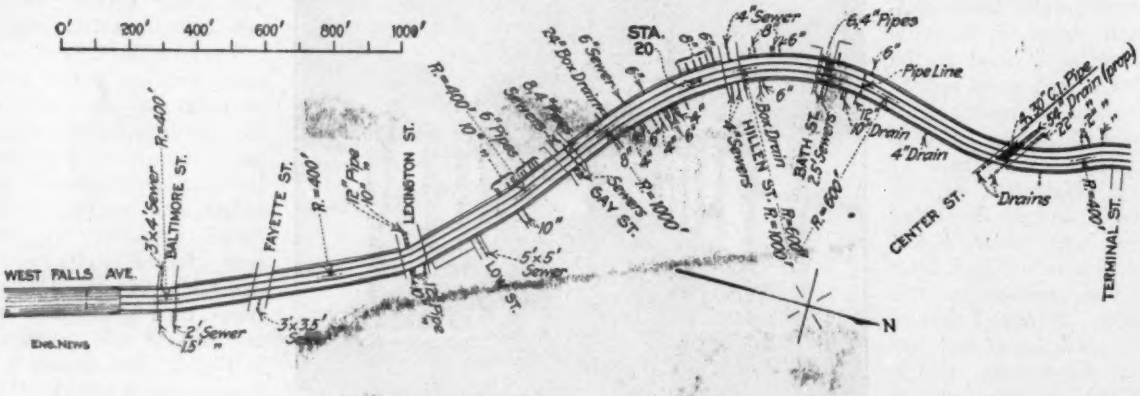


FIG. 2. PLAN OF COVERED PORTION

way connecting the northern part of the city with the business and wharf districts at the south, it was decided in 1910 to cover the Falls from a point near its mouth through the business districts of the city and to pass the normal flow of the Falls together with storm-water drainage through the conduits thus provided, at the same time paving the cover of the structure so as to make a wide street.

The city of Baltimore is a succession of steep hills, on which it is exceedingly difficult to carry heavy trucking. A particularly hard group of hills exists between the railway stations (Union Station, Pennsylvania and allied lines, and the Mount Royal Station, Baltimore & Ohio R.R.) and the wharf district. It so happens that the line of the Falls makes an almost direct street between these two upper stations and the wharf, on which the grade is quite easy. This new street then will undoubtedly be used for all the heavy trucking between the important railway and steamship centers. Furthermore, the Falls were originally at the rear of a number of business houses, which houses fronted on narrow and tortuous streets. In nearly every case the entrance to these buildings will be changed from the narrow street to what was formerly the rear, but what is now the front of the broad so-called Fallsway.

THE FALLS THE FALLSWAY

FIG. 3. JONES' FALLS BEFORE AND AFTER

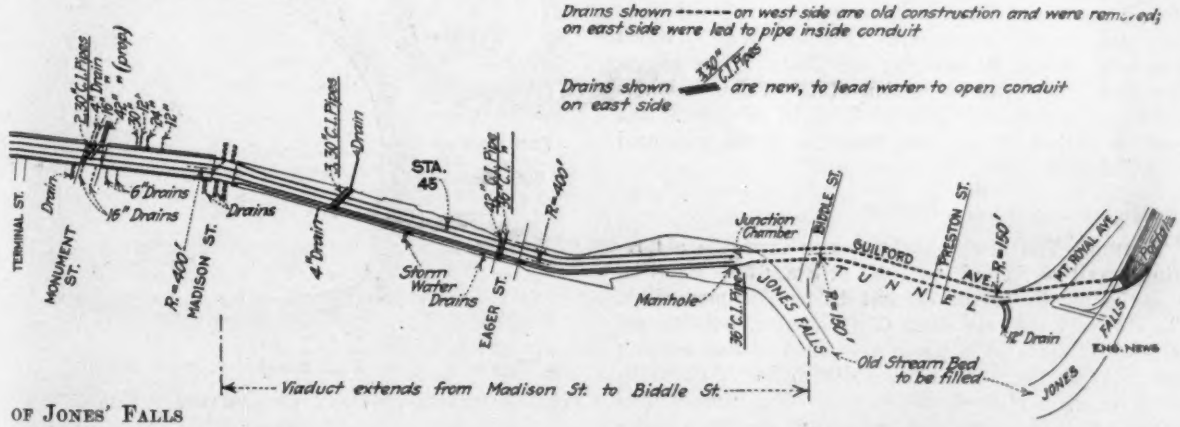
GENERAL PLAN OF WORK

The extent of the work at present outlined is shown on Figs. 1 and 2. Starting just south of the Union Station the Falls enter a 1200-ft. tunnel, 29 ft. in diameter, which cuts off a horseshoe curve in the original alignment of the Falls. At its south portal the tunnel enters a conduit which extends south 5500 ft. to a point just south of Baltimore St. where it runs into an open paved channel and thence through its original channel some two blocks south to the harbor.

Baltimore St. is about the north end of the tidal level in the creek, so it was decided for the present to allow it to run in its open channel from that point to the harbor. If in the future it is thought commercially necessary to cover the Falls below that point so as to provide more trucking room it will be done. However, the grades on the surrounding streets are quite flat here so that it probably will not be undertaken for some time.

At the south end of the tunnel the bottom of the Falls is some 50 ft. below the surrounding street, so that a street immediately upon the top of the conduit was not permissible. Therefore, from Biddle St. (see Fig. 1) north to the intersection of the line of the tunnel with Guilford Ave. at Madison St. the Fallsway is carried on an arch viaduct to the normal grade of Guilford Ave. This arch viaduct intercepts the numerous present bridges across the Falls at grade. Below the viaduct all the present streets which are carried across the Falls on bridges will cross the new conduit street, or Fallsway, at grade.

The completed structure will consist of a paved street



OF JONES' FALLS

72 ft. wide and over 7000 ft. long, with a 50-ft. roadway and two 12½-ft. sidewalks rising on a level grade from Baltimore St. to Biddle St. and on a 3% average grade on the viaduct from there to Guilford Ave. at Madison St. The lower portion will be directly on the conduits carrying Jones' Falls and the upper portion on an arched viaduct resting on this same conduit and on the ground above the tunnel. The street naturally has some curves as it follows, with the exception of the tunnel cutoff, the original line of the Falls.

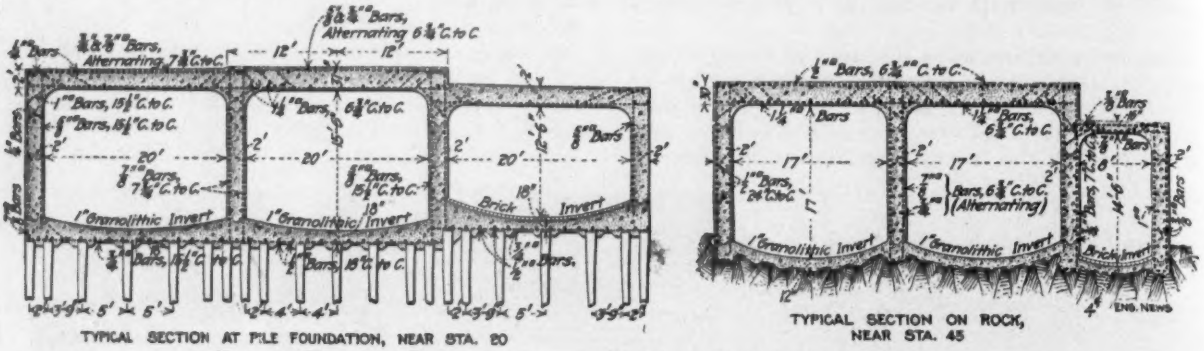


FIG. 4. TYPICAL SECTIONS OF THE CONDUIT, JONES' FALLS COVERING

The conduit section, which was let in two contracts, is practically completed. The tunnel section is now under construction, the tunnel being nearly holed through, and the viaduct section was let on May 21, 1913.

For the present, at least, it is not proposed to carry the Falls covering any farther north than the northern portal of the tunnel. Riparian rights north of the portal of the tunnel are vested partly in the city, partly in private owners and partly in the railways. Until it is definitely settled that the railways will not use the covering for any of their track, it is not intended to cover the Falls. At this point the creek level is far below that of the surrounding streets and a parking treatment with grass slopes from the streets is more satisfactory from the artistic standpoint. The street area, which would be gained by covering the Falls, is not necessary here. The curved portion of the Falls, which is cut off by the tunnel, will be filled in as soon as the water is turned through the tunnel, and the area used for building purposes.

DESIGN

TUNNEL—The new tunnel takes in from the old retaining-wall section of the Falls at Sta. 67 + 64 (Sta. 0 is the mouth of the conduit below Baltimore St.). The old walls here are about 65 ft. apart and the tunnel entrance is made by a paved and lined section curving and reducing from the 65-ft. width to the 29-ft. width which is the width of the tunnel. The tunnel then passes in three tangents with two connecting curves under a hill, which at its maximum point is about 50 ft. above the crown of the tunnel arch to its south portal in the old bed of Jones' Falls, 1200 ft. south of the north portal.

The tunnel is in soft ground near both portals, at which location it will have a section similar to that shown at the top of Fig. 5. In its middle portion, however, it is in hard rock where it has the lined section shown to the right in Fig. 5. It is nearly as large as the largest double-track railway tunnel, being a horseshoe section 29 ft. wide and 28 ft. high. It is driven on a southerly grade of 0.003. Near the south approach of the tunnel it is penetrated by a 12-ft. tunnel section which carries an existing storm-water drain which empties into the old Jones' Falls in the bend that is being eliminated. This storm-water drain is to be continued across old Jones' Falls and as a tunnel through the rock into the new tunnel, as shown in Fig. 5. In its rock section it is circular, 12 ft. in diameter, and in other sections horseshoe shape

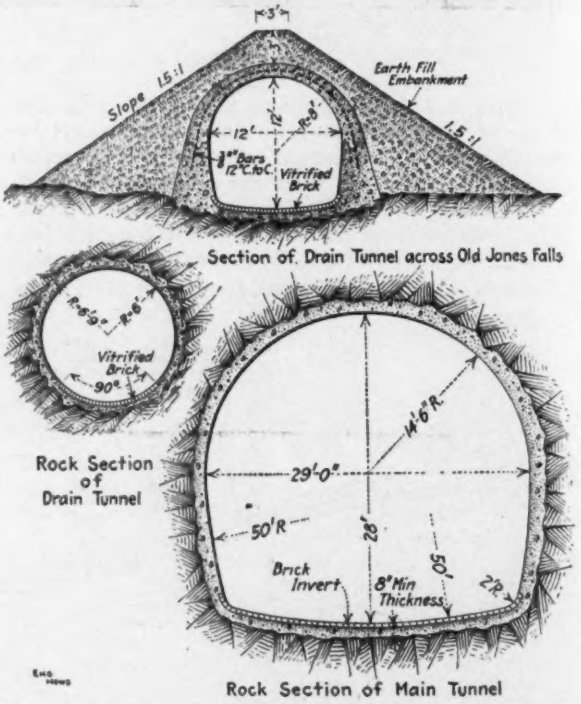


FIG. 5. DETAILS OF MAIN AND DRAINAGE CONNECTING TUNNEL

12 ft. wide and 12 ft. high. As will be noted below under the heading "Construction," this smaller tunnel was used as a construction tunnel in the building of the large one.

CONDUITS—From the south portal of the tunnel to the open channel south of Baltimore St. the Falls are carried in a conduit of varying size but of the same gen-

eral design. The typical section comprises on the west two equal-sized so-called pressure tubes, and on the right a smaller gravity tube through which the normal flow of the Falls will pass. The normal flow tube varies in size from 8x14½ ft. at the south portal of the tunnel to 20x12½ ft. at the mouth near Baltimore St. It has an arched invert paved with vitrified brick and is intended to carry the normal flow of the Falls under gravity, together with the street drainage from the area to the east of the Falls. The remaining two tubes are designed to carry the excess flow during high-water periods and will take this flow under pressure. They vary in size each from 17x17 ft. at the upper end to 20x15½ ft. at the lower end. These pressure conduits are rectangular in section, as shown in the figure, with a granolithic concrete invert.

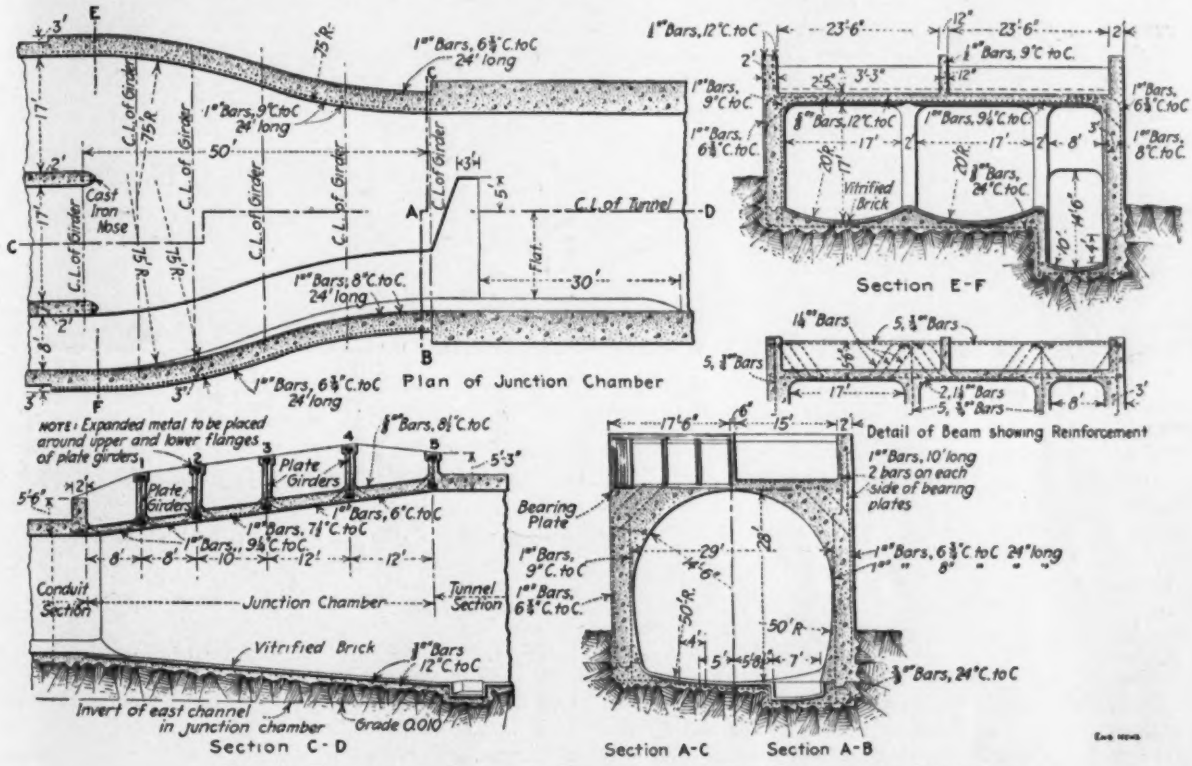


FIG. 6. DETAILS OF JUNCTION CHAMBER BETWEEN TUNNEL AND CONDUIT

The whole structure is carried at the upper part upon solid rock which tails out toward the lower end of the conduit so that it had to be carried there on timber piles, as shown in Fig. 4. The conduit structure is built well within the old sidewalls, and the intervening space is subsequently filled in with earth, the whole forming a crown base upon which a belgian-block pavement is laid. As noted, the east or smaller conduit will carry the normal flow, and when the flow of the stream becomes so great that this opening would be put under pressure, it is automatically diverted to the other two conduits which are designed to carry a maximum of 15,000 cu. ft. per second. This at the lower end of the tube involves a pressure head of about 12 ft. on the interior of the conduit, for which the two pressure sections had to be designed.

Fig. 6 shows the method of insuring diversion of the water through the proper channel. A so-called junction chamber will be built between the south portal of the tunnel and the north opening of the three conduits. This junction chamber enlarges in plan and decreases in height so as to make a smooth connection between the tunnel section and the three conduit sections. It comprises a concrete base laid on the solid rock and reinforced as shown, and a roof made up of steel plate-girders spanning between the sidewalls and incased with concrete, carrying the roof slab of the chamber. At the portal of the tunnel a channel is cut lower than the normal channel of the tunnel and leading to the east conduit, which is throttled at the north end of the conduit to the 14½x8-ft. section shown at the upper right-hand of Fig. 4. All normal flow of water then will naturally drop into the east channel until the portal is carrying as much as it is able, beyond which amount the conduit would be under pressure, taking into account the extra water led into it from that point to the mouth of the conduit by the numerous storm drains. When the flow of water in the drainage area of Jones' Falls, therefore, reaches a point too great for the east channel, it automatically will pass into the two pressure conduits, which, being designed to take water under pressure, cannot take any of the storm drains. All storm drains, therefore, on the west side of Jones' Falls are led into an intercepting drain which is built of cast iron and suspended from the side of the conduit wall.

As shown in the various typical sections in Fig. 4, the conduit is composed of vertical walls with invert of concrete and a concrete roof, all tied together by sufficient reinforcing to guarantee its static stability against internal pressure in the main conduit and its stability

to take the load of a normal street. This roof is designed to take the regular Pennsylvania R.R. train loading, although it is never expected that any trains will run on the covering. When the conduit is finished, the space between the concrete walls and the old masonry walls are filled in with earth and the street crowned to take the face of a regular belgian-block pavement. Fig. 3 shows views of a certain section of the work before and after the construction of the covering.

Below Baltimore St. the paved channel consists merely of the normal invert section of the remainder of the conduit, so that if in the future the covering is to be carried farther south, the sidewalls and roof can be added directly to the already placed invert. This paved section extends only 200 ft. below Baltimore St., the remainder of the Falls being left in its present state, that is, a creek running between stone retaining walls.

Viaduct—The details of the viaduct, which is to extend from Biddle St. to Guilford Ave., are shown in Fig. 7. The contract for this viaduct has just been let and construction will not be completed for some time. As noted on the drawing, it consists of a series of arches carrying the Fallsway from grade at Biddle St. to grade on Guilford Ave., at Madison St., the top of the conduit at this location being so far below the grade of the adjoining street that the Fallsway, if constructed on the conduit, would not have been of any use as a thoroughfare. The viaduct is about 1520 ft. long, comprising in the southerly portion a series of 17 arches carrying the roadway on reinforced-concrete floor system and wall, and for the northern 480 ft., an earthfill between retaining walls in line with the piers and spandrel walls of the arch viaduct. Each of the transverse streets is crossed at grade and a solid fill is made at these points. The arches are from 54 to 65.5 ft. c. to c. span and the ratio of rise to span is 1 : 7.6.

Each arch (Fig. 7) comprises nine arch ribs spanning between transverse beams, which in turn rest on columns which foot on bases continued up from the walls of the conduit. In constructing the conduit, the bases for these columns are prepared and reinforcement is allowed to protrude so that it may be joined in future to the reinforcement of the pier walls on which the arches rest.

At the lower portion of the viaduct it is of irregular width due to the curve there. At this location, the floorbeams are irregular in shape, size and location. Beyond Eager St., however, the piers are at right angles to the line of bridge and the floor structure becomes regular in design. Details of reinforcement are shown on Fig. 7.

It is intended to make the structure as ornamental as is consistent with the money available and to provide profuse illumination. Expansion is provided in the viaduct by the construction joints in the concrete roadway over the high walls at each pier.

Construction

The tunnel and conduit work was let in two sections. Section 1, extending from the mouth of the conduit 100 ft. south of Baltimore St. to a point about 100 ft. south of Center St. (Station 28), all in conduit, to M. M. Elkan, Macon, Ga. (sublet to the Elkan-Tufts Co., Baltimore, Md.); Section 2 from the north end of Section 1 to the north portal of the tunnel and including both tunnel and conduit, to Fisher and Carozza, of Baltimore. They have sublet the tunnel work to Lane Bros. Co. The viaduct has just been let to Clairborne-Johnson Co.

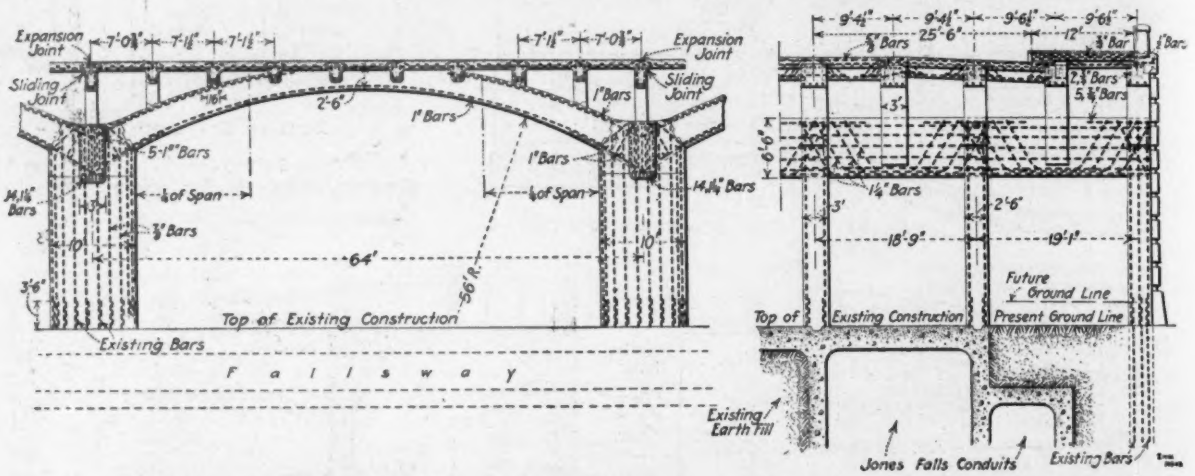


Fig. 7. Details of Viaduct to Carry Fallsway from Madison to Guilford Ave.

Conduits—Except in some details the conduit construction was carried on in the same manner throughout its 5500-ft. length. The successive steps are shown in the accompanying half-tones. Fig. 8 shows the Falls, before construction commenced, flowing only partly full. In this section there was driven along the middle line a coffer-dam, made up of two rows of 3-in. timber sheeting 4 ft. apart and filled in between with excavation from the bottom of the Falls. This coffer-dam was completed for the entire section in Section 1 and for all except the portion near the tunnel in Section 2, and the flow of the stream diverted to the west half of the bed. In the dry half then steam shovels were put to work excavating the bottom to grade, a maximum cut of about 5 ft. Meanwhile all of the drains and sewers on the east side of the Falls had to be carried across the cut to sewers on the opposite side, or allowed to waste into the flowing half of the Falls (Fig. 8). The spoil from the steam shovels was run on narrow-gage trains to the nearest bridges where the material was dumped into

FIG. 8. FIRST STAGE OF CONDUIT CONSTRUCTION, LOOKING NORTH
(Coffer-dam in place; flow through west half; excavation in east half.)

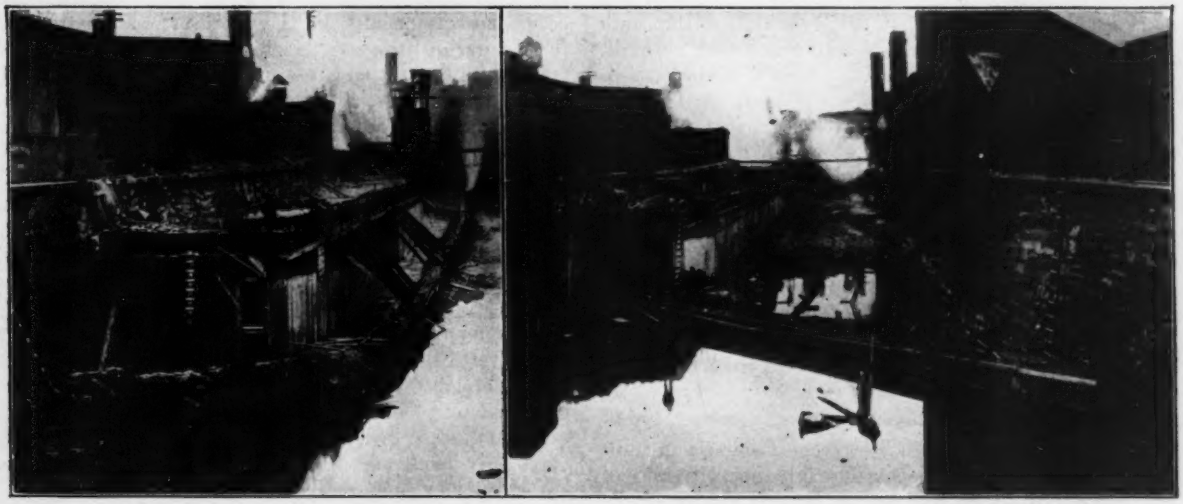


FIG. 9. SECOND STAGE OF CONDUIT CONSTRUCTION, LOOKING SOUTH
(Flow through west half; construction of gravity tube going on in east half.)

FIG. 10. THIRD STAGE OF CONDUIT CONSTRUCTION, LOOKING SOUTH
(Flow diverted through completed gravity tube; excavation going on in west half.)

hoists emptying into carts on the street level and taken away.

When grade was reached and the necessary piles driven, the east conduit, which is the gravity section, was built (Fig. 9) leaving protruding reinforcement onto which the subsequent parts of the structure were bonded. In the lower part of the conduit wooden forms were used for the sections, while in Section 2 some steel forms were used.

When the complete east conduit was finished the water was diverted to that section, as shown in Fig. 10, and the construction of the pressure conduits carried on in the west half of the Falls, precisely as the east conduit was built, except that all drains on this side of the Falls had been carried into the final intercepting drain and no cross pipes were required.

When the space alongside the old retaining walls permitted, concrete was deposited from cars running along the top of the walls from the mixing plants located at intervals along the work. For the greater part of the line, however, space did not permit this method and mixing plants were set up at the bridges, with the gravity

chutes to carry the concrete to its proper location. In these plants the sand, stone and cement were brought in on street level to the mixer. Section 1 was laid with gravel concrete brought in from Chesapeake Bay, but in Section 2 the stone from the tunnel was crushed on the ground and used for the concrete of the conduits. In both cases sand was brought in from local deposits.

On several occasions during construction, floods in the Falls became so high as to overtop the coffer-dam and to stop work for a time, but no very great damage was done, the equipment being mostly above the creek bottom and the forms easily recovered when washed downstream.

The Sewerage Commission undertook only to build the conduit and to fill the intervening space between it and the old walls to grade. When this grade was reached the work was turned over to the Street Department of the city which built the Fallsway paving and sidewalk, as shown in a nearly completed section in Fig. 3.

TUNNEL—The 1200-ft. tunnel is through a hard compact limestone, which does not require timbering except at occasional points. It is being driven in full heading from both portals and both ways from the middle, where entrance was gained through the 12-ft. drainage tunnel section, which is to take care of the existing Jenkins Run drain, as described in the first part of this article. The longer part of the tunnel was driven from this middle entry, the spoil being hauled out through the small tunnel to a crushing plant located at the mouth of the 12-ft. tunnel on the bank of the Falls at the bend which is being cut across by the tunnel. This crusher is used in reducing the stone to concrete size to be used in the construction of the conduit to the south and, it is hoped, in the new viaduct about to be built. At the south portal of the main tunnel a similar crushing plant is in use to care for the spoil brought out here.

A shaft has been sunk at Guilford Ave. and Preston St., through which all concrete for lining the tunnel will be dropped to the tunnel level, thence to be carried on cars to its proper location. Alongside of this shaft the main mixing plant of this part of the work is erected, stone being brought from the adjacent crushing plants, and the cement and sand carted there over the city streets. At the present writing the tunnel has been holed through for full heading and the concrete lining is just being started.

PERSONNEL

As Chief Engineer of the Sewerage Commission, Calvin W. Hendrick was responsible for the initiation of the Jones' Falls work and he has been in charge of the design and construction of the Jones' Falls covering. Alfred H. Hartman, Division Engineer, is in immediate charge of construction.

The Source of Heavy Rainfalls*

The amount of moisture in the atmosphere, say up to 30,000 feet above sea level, can be roughly computed if the dew point is approximately known; all such computations, however, are made on the assumption that the air is saturated and that all of the moisture is precipitated, conditions known not to be fulfilled in nature; therefore, the computed amounts must always be in excess of the true amounts.

If we take the Ohio Valley, for example, and compute the total amount of aqueous vapor in the overlying air up to 30,000 ft. and express it as the depth of water it would be equal to if all of it be precipitated as rain, we would probably be surprised to find that even under the most favorable assumptions it would barely equal an inch of water. When it is considered that occasionally ten times as much rain falls as computation shows is available, the question naturally arises: Whence comes the moisture to produce the torrential rains which occasionally occur?

The conclusion is inevitable that air from the regions immediately surrounding the atmospheric disturbance must be continually drawn in and carried aloft in the general movement of air about the storm center. Convectional currents, therefore, must be intimately associated with unusually heavy and continuous precipitation, otherwise the rainfall would cease when the major portion of the moisture normally in the undisturbed air over a place has been precipitated.

The air thus drawn in on the southeast quadrant of storms which occupy the great interior valleys, coming, as it does from lower latitudes, is at a higher temperature and possesses greater moisture content than does air which is drawn in toward the storm center in the northern and western quadrants; hence it would seem that the wind circulation about a storm center thus described has an important bearing on the explanation of the observed fact that thunderstorms, tornadoes and excessive rains occur most frequently in the southeastern quadrant of the general disturbances which pass from west to east or from southwest to northeast over the United States.

Ferrell was probably the first to associate tornadoes with convectional currents. His theory of tornadoes is based essentially on the occurrence of an ascensional movement, of which there is now ample evidence, in a tornado whirl. It has been clearly established that both tornadoes and thunderstorms mainly occur within the southeast quadrant of a larger general disturbance, technically known as a cyclone, or area of low pressure, the latter being expressed on the daily weather map by the single word "Low."

The vertical instability necessary to produce tornadoes is not developed in every Low, but there is sufficient vertical instability in almost every Low to produce general rains, and these may or may not be intense; some Lows yield only moderate precipitation over a limited area, but there may be several "islands," so to speak, of intense rainfall within the larger area of moderate rainfall, while in still other Lows the area of excessive rainfall may be continuous and of considerable extent.

As a rule, surface indications as plotted on the daily weather map do not afford any clear indication of whether the rainfall will be heavy or light, yet constant association with the weather maps leads to skill in interpreting conditions which produce rain; consequently it has been recognized that certain conditions which occur in winter and spring are quite apt to produce heavy rains in the Mississippi and Ohio Valleys. The fact that the Low of Mar. 23 caused tornadoes in one portion of its course and torrential rains in another is merely an indication that the physical conditions which determine atmospheric instability were highly developed then.

*From a paper by Prof. Alfred J. Henry, in charge of the River and Flood Division of the U. S. Weather Bureau, in the "Monthly Weather Review."

Municipal Building Laws in the United States

By R. Fleming*

A study of the building codes of the leading cities in the United States affords some interesting comparisons. While a standard code may not be practicable in all of its requirements as long as local conditions vary as they do, there is no good reason for many of the differences at present existing between the building laws of our cities. It is to be remembered that any requirement of a building code that is excessive adds unnecessarily to the cost of a proposed building and may be prohibitive to its erection. A city may thus be impeded in its growth by a needlessly severe building code. Extreme refinements are undesirable inasmuch as they become looked upon as something to be evaded rather than to be followed. An ambiguity or lack of clearness in expression is also unfortunate. In these days of keen competition in all lines of building work the interpretation that produces the cheapest structure will be put upon any clause admitting of more than one meaning.

This article, based on a review of the codes of 35 cities, will be confined to those features which concern the structural engineer in designing the steel frames of tall buildings of fireproof construction. Wide differences in this field are uncalled for; where such are found, in comparing any two codes, the conclusion may generally be drawn that one or both codes need revision.

The present Building Code of the City of New York, affecting as it does more building operations than the code of any other city on the continent, was adopted in 1899. It is archaic in some of its provisions and is inadequate for present needs. In 1909 a new code was passed by the Board of Aldermen but was vetoed by the Mayor; the extended discussion and bitter controversy regarding the proposed code are well remembered. The present code has often been used as the basis for the codes of other cities. Sometimes it has been copied with but little change, and in other cases some sections have been followed while others have been modified or rejected.

Dead-Load—All codes require the full dead-load of buildings to be carried by the steelwork to the foundations and footings. What does the term dead-load cover? Are the partitions of a building to be considered as live- or dead-load? As the partitions of a typical hotel or office building weigh 8 to 15 lb. per sq.ft. of floor surface, quite a loophole is left to the designer in this matter if the question is not decided by the code. New York, Chicago, Detroit, Minneapolis, San Francisco, are specific in classing partitions as part of the dead-load. In St. Louis, "loads that are movable and transient, and that are not a part of the building," are classed as live-loads. The Rochester code excepts from the dead-loads "partitions not over 6 in. in thickness." The Philadelphia laws by inference allow the partitions to be considered as part of the live-load.

Live-Load—Table I shows the minimum live-load to be carried on the floors of hotels, office buildings, places of public assembly, and retail stores, as specified in the codes of the cities listed. It is believed the building laws now in force are quoted in each case. No reference is made to Cincinnati, Pittsburgh, Washington, New Haven, Hartford, Cleveland, Milwaukee, or Denver, as their codes are in various stages of revision.

Are the openings for stairways to be included in or deducted from the floor surface in calculating total live-load? It will be observed that a definite load for stairways is fixed in a number of codes. In five of the 20 cities listed a distinction is made between places of public assembly with, and those without fixed seats. The wisdom of this seems doubtful, though there is something to be said in its favor.

Reduction of Live-Load—For a building of many

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TABLE I. MINIMUM LIVE LOADS FOR FLOORS, AS SPECIFIED IN 20 MUNICIPAL BUILDING LAWS

(Pounds per square foot of surface)

City	Hotels	Office bldgs.	Places of public assembly	Retail stores	Remarks
New York, Newark, Jersey City, Atlanta	60	150—1st floor 75—above 1st	90	120	
Chicago	50	50	100	100	Stairways for bldgs. of all classes, not less than 100
Philadelphia	70	100	120	120	
Boston	50 For room > 500 sq.ft.—100	100	125	125	Stairs, landings, platforms, fire escapes—70
St. Louis	60	150—1st floor 75—above 1st	100	150	
Baltimore	60	150—1st floor and basement 75—above 1st	75 with fixed seats 125 without fixed seats	125	
Buffalo	70	70	100	120	
Detroit	80—1st floor, hall, lobbies and public rooms. 50—private apartments	125—1st floor 75—others	80 with fixed seats 100 without fixed seats 100—lobbies and passages	125—1st floor 100—others	Stairways in places of public assembly—125
Minneapolis	50	100—1st floor 75—above 1st	125	100	
Providence	50 For room > 500 sq.ft.—100	150—1st floor 75—others	125	125	Stairs liable to be crowded—125 Not so liable—70
Worcester	60	125—1st floor 75—above 1st	100	125	
Rochester	60	70	80—theatres 70—others	100	
Syracuse	60—private rooms and apartments 80—elsewhere	75—offices proper 100—elsewhere	80 with fixed seats 100 without fixed seats	125	Lobbies, halls, stairs } 100 in office bldgs. and places of public assembly. 80 in hotels
Louisville	60	150—1st floor 75—above 1st	100	Not stated	
San Francisco	60	60	75 with fixed seats 125 without fixed seats	125	
Los Angeles	60	75	125	150	Hotel corridors—125
Seattle	125—ground floor 75—above gr. fl.	125—ground floor 75—above gr. fl.	80 with fixed seats 100 without fixed seats	125—ground floor 100—above gr. fl.	Lobbies, passages, corridors and stairways of places of public assembly—100

stories in height (unless used for storage purposes) it is exceedingly improbable that all floors will be fully loaded at the same time. Even on a single floor the full live-load is not as liable to come upon the girders as upon the beams framing into them. Shall a reduction of live-load be made for floor girders? What reduction shall be made for columns? In their answers the codes are far apart.

A reduction of 5% to 20% of the live-load is allowed on floor girders in Boston, Providence, Philadelphia, St. Louis, Rochester and San Francisco. A reduction of floor live-loads on columns is allowed by the New York code for buildings over five stories in height of the classes listed in Table I as follows:

> For the roof and top floor the full live-load shall be used; for each succeeding lower floor it shall be permissible to reduce the live-load by 5% until 50% of the live-load fixed by this section is reached, when such reduced loads shall be used for all remaining floors.

A number of other codes use this method of reduction. Boston and Providence each allows a reduction of 15% of the total live-load for columns carrying two floors, a reduction of 20% for columns carrying three floors, etc., up to a reduction of 50% of the total live-load for columns carrying nine or more floors. Chicago calls for 85% of the full live-load on the top floor, 80% on the floor below, 75% on the second floor below, down to 50% for the seventh and other floors below the top floor. Philadelphia uses the formula $X = 100 - \frac{1}{6}\sqrt{A}$ for hotels and office buildings and $X = 100 - \frac{2}{3}\sqrt{A}$ for stores, in which X denotes the percentage of live-load to be used and A denotes the area carried by any girder, column, or foundation. The St. Louis code requires a column to carry the full live-load of the floor immediately above, for the floor second above 95% of its live-load, and for each succeeding floor above a proportion diminished by not more than 5% is allowed until 40% is reached. In Detroit the columns of hotels and office buildings over three stories in height are required to carry 60% of the live-load on all floors except the top one, those of places of public assembly 70%, and of stores 70%. In San Francisco the columns of hotels, office buildings, and places of public assembly carry 60% and of stores 100% of the live-load on floors. Buffalo, Atlanta and Los Angeles have nothing in their codes regarding reduction of live-load on columns.

In accordance with the above, the lower tier of columns in a 12-story office building will be required to carry a live-load from the floors of 695 lb. per sq.ft. of ground area if the building is in New York, 372 lb. if in Chicago, and if in Philadelphia (and the columns support not less than 300 sq.ft. of area) 1033 lb.

Foundation Pressures—Proper foundations are vital to the life of a building. They should be of sufficient area to distribute the loads coming upon them. This area is determined by the bearing capacity of the soil upon which they rest. As some settlement is bound to take place it is important it should be uniform throughout the building. This would occur provided the pressure under the footings was everywhere the same per unit of area. But the dead-loads only are constant. The live-loads are varying and intermittent. The ratio of live-load to dead-load also varies. It is quite different in the corner and wall columns from what it is in the interior columns. The proportioning of the footings is, therefore, largely a matter of well trained judgment. There is no common practice among engineers.

Building laws are at variance on the subject. Many of them are silent. Chicago, Philadelphia, Boston, Detroit, Minneapolis and San Francisco call for footings to be designed for the same live-loads as carried by the lower sections of columns. Of course, in all cases the full dead-loads are to be carried. The New York code, in buildings more than three stories in height, calls for the live-load on footings to be taken as 60% of the live-load on the lower tier of columns for hotels and office buildings, and 75% for places of public assembly and stores. This rule is followed by Newark, Jersey City and Atlanta. The St. Louis law calls for an average live-load of not less than 10 lb. per sq.ft. of all the floor area of the building for hotels and office buildings, and 20 lb. per sq.ft. for stores. In Baltimore the supporting areas of foundations for hotels, office buildings, places of public assembly, and retail stores, are to carry one-quarter of the full live-loads specified for floors and roofs. The Buffalo code reads:

> Foundations shall be proportioned to the actual average loads they will have to carry in the completed and occupied building, and not to theoretical or occasional loads.

This sentence is so indefinite it might well be omitted. In Syracuse it is provided that the live-load carried by the foundations of hotels and office buildings shall not be less than 60% of the total live-load on the floors contributing thereto. For places of public assembly and retail stores 75% is used. (The method prescribed in the Syracuse code for proportioning footings, having given the live- and dead-loads coming upon them, is that given in Schneider's "General Specifications for Structural Work of Buildings.")

Working Stresses—For the cities listed, Table II gives the permissible working stresses for medium steel in compression, tension. shear, and bending, also for round cast-iron columns in compression.*

Here again we have inconsistencies and needless differences. Is there any reason why the extreme-fiber stress in bending should be different in rolled sections and riveted sections? The working stress for steel in direct tension is the same throughout the list. For a steel column with $\frac{L}{R} = 60$ the permissible working stress in compression varies from 11,350 lb. per sq.in. in St. Louis to 13,550 lb. in Boston. In New York it is 11,720 lb. The allowable compressive stress in a cast-iron column of 10-in. outer diameter, 1¼-in. shell, and 12 ft. high, varies from 6340 lb. per sq.in. in San Francisco to 10,400 lb. in Buffalo. In New York the value is 9914 lb. per sq.in. According to the proposed New York code of 1909 which was vetoed, its value was 7160 lb. per sq.in. St. Louis, Providence, Worcester, and Los Angeles still use the obsolete "factor of safety." The Worcester ordinance regarding the compressive strength of columns is unique. Is it followed in Worcester? Who is "the best authority" on this subject?

Cast-Iron Columns—In New York, Chicago, Boston Rochester and Syracuse the unsupported length of a cast-iron column must not exceed 70 times its least radius of gyration. In Philadelphia and San Francisco the unsupported length must not exceed 20 times the diameter,

*In addition to the formula for round columns in compression given in Table II, Buffalo, Minneapolis, San Francisco, and Louisville have a formula for cast-iron columns of square or rectangular section.

TABLE II. WORKING STRESSES FOR STEEL AND CAST IRON, AS SPECIFIED IN 20 MUNICIPAL BUILDING LAWS

(Pounds per square inch of sectional area)

City	Medium Steel				Cast Iron
	Columns in compression	Direct tension	Shear: web pls.	Shear: shop-driven rivets	Extreme fiber stress in bending	Round columns in compression
New York, Newark, Jersey City, Atlanta	$15{,}200 - 58\frac{L}{R}$	16,000	9,000	10,000	16,000 Rolled sect's 14,000 Net riveted "	$11{,}300 - 30\frac{L}{R}$
Chicago	$16{,}000 - 70\frac{L}{R}$ 14,000 max.	16,000	10,000	12,000	16,000	$10{,}000 - 60\frac{L}{R}$
Philadelphia	$\frac{16{,}250}{1 + \frac{L^2}{11{,}000\ R^2}}$	16,250	10,000	11,000	16,000	$\frac{11{,}667}{1 + \frac{L^2}{400\ D^2}}$
Boston	$\frac{16{,}000}{1 + \frac{L^2}{20{,}000\ R^2}}$	16,000	10,000	10,000	16,000	$11{,}300 - 30\frac{L}{R}$
St. Louis	$\frac{12{,}500}{1 + \frac{L^2}{36{,}000\ R^2}}$	Factor of Safety of 4				$11{,}100 - 220\frac{L}{D}$
Baltimore	$\frac{15{,}000}{1 + \frac{L^2}{13{,}500\ R^2}}$	16,000	9,000	10,000	16,000 Rolled sect's 15,000 Net riveted "	$\frac{11{,}000}{1 + \frac{L^2}{10{,}000\ R^2}}$
Buffalo	$17{,}100 - 57\frac{L}{R}$ 12,000 max.	16,000	10,000	9,000	16,000	$\frac{14{,}000}{1 + \frac{L^2}{600\ D^2}}$
Detroit	$16{,}000 - 70\frac{L}{R}$ 12,000 max.	16,000	10,000	10,000	Factor of safety of 4	$\frac{10{,}000}{1 + \frac{L^2}{800\ D^2}}$
Minneapolis	$17{,}100 - 57\frac{L}{R}$ 12,000 max	16,000	10,000	9,000	16,000	$\frac{13{,}330}{1 + \frac{L^2}{400\ D^2}}$
Providence	Factor of Safety of 4					Factor of safety Short cols. 6–8 Long cols. 8–10
Worcester	*See note below	¼ ultimate	¼ ultimate	¼ ultimate	¼ ultimate	*See note below
Rochester	$15{,}200 - 58\frac{L}{R}$	16,000	9,000	10,000	16,000 Rolled sect's 14,000 Net riveted "	$11{,}300 - 30\frac{L}{R}$
Syracuse	$15{,}200 - 58\frac{L}{R}$	16,000	10,000	10,000	16,000 Rolled sect's 16,000 Net riveted "	$9{,}000 - 40\frac{L}{R}$
Louisville	$17{,}100 - 57\frac{L}{R}$ 12,000 max.	16,000	9,000	10,000	16,000 Rolled sect's 15,000 Net riveted "	$\frac{10{,}000}{1 + \frac{L^2}{800\ D^2}}$
San Francisco	$15{,}000 - 50\frac{L}{R}$ 13,500 max. 12,000 max. for ¼" metal	16,000	9,000	10,000	16,000 Rolled sect's 15,000 Net riveted "	$\frac{8{,}000}{1 + \frac{L^2}{800\ D^2}}$
Los Angeles	Factor of Safety of 4					
Seattle	$16{,}000 - 70\frac{L}{R}$ 14,000 max.	16,000	10,000	12,000	16,000	$10{,}000 - 61\frac{L}{R}$

*The Worcester ordinance provides that columns and piers of less than five diameters shall be loaded to not more than one-sixth their crushing strength. "Columns or piers of more than five diameters are to be increased according to the formulae of the best authority."

in St. Louis 25 times, in Buffalo and Minneapolis 30 times.

Chicago and Baltimore each restricts the use of cast-iron columns to buildings not more than 100 ft. high, Seattle to buildings not more than 80 ft. high, and Boston 75 ft. high. Chicago and Seattle also forbid their use in buildings of a height more than twice the least width. Buffalo limits their use to buildings less than ten stories in height. Baltimore specifies that the width of buildings in which they are used is not to be less than one-third their height; also "The carrying capacity and maker's name shall be cast on every iron column."

WIND PRESSURE—The New York code requires that all structures exposed to the wind (except those under 100 ft. in height in which the height does not exceed four times the average width of the base) be designed to resist a horizontal wind pressure of 30 lb. in any direction for every square foot of surface exposed from the ground to the top of same, including roof. In calculations for wind bracing the working stresses set forth in the code may be increased by 50%. Rochester, Minneapolis, Louisville, Atlanta, Newark, and Jersey City follow the New York code. In Philadelphia and Syracuse a pressure of not less than 30 lb. per sq.ft. is called for on buildings erected in open spaces or on wharves. In high buildings erected in built-up districts the wind pressure is not to be figured for less than 25 lb. at tenth story; 2½ lb. less on each succeeding lower story, and 2½ lb. additional on each succeeding upper story to a maximum of 35 lb. at the fourteenth story and above. In proportioning members subject to stresses due to wind loads the working stresses may be increased 30% in Philadelphia and 25% in Syracuse. Detroit calls for 30 lb. per sq.ft. pressure and allows the working stresses to be increased 25%. Baltimore and Buffalo each assumes the wind pressure at 30 lb. per sq.ft., but say nothing regarding any increase of working stresses. Chicago and San Francisco call for 20 lb. per sq.ft. wind pressure and an increase of 50% to the working stresses is allowed. Providence and Los Angeles are silent on the subject of wind pressure. Seattle allows an increase of 50% to the working stresses but does not give the amount of pressure.

On the whole subject the Boston code has only the single sentence, "Provision for wind bracing shall be made wherever it is necessary." This is indefinite and tends to put a premium on ignorance. If all designers were experts there would still be enough difference of opinion as to the amount of wind bracing necessary. But a design with little or no wind bracing is also entitled to a hearing, if the maker assures he is furnishing bracing "wherever it is necessary."

St. Louis requires a wind pressure of 30 lb. per sq.ft.

and allows an increase of 20% to working stresses. The St. Louis code has the provision, "Where there are buildings immediately adjoining, the wall surface covered by such buildings will be considered as not exposed to wind pressure."

LIMITING HEIGHT OF BUILDINGS—Only a few cities place a limit to the height of fireproof buildings of the first class. In Boston no building is allowed to be of a height more than 2½ times the width of the widest street on which it stands, or in any case to be more than 125 ft. high. It St. Louis the limiting height is 250 ft., in Baltimore 175 ft., in Buffalo and Rochester not more than four times the average of its horizontal dimensions.

In this connection see an article, "Municipal Regulations on the Height of Buildings," in ENGINEERING NEWS, Feb. 15, 1912. Of 30 cities there listed, 19 had no ordinances governing the height of buildings of any class.

SPECIAL FEATURES—A number of codes have some requirements special to the cities for which they are written. Most codes require that there shall be not less than 8 in. of fireproofing, generally brick, on the outside of all exterior columns. In Newark and in Louisville there is required in addition to the 8 in. of fireproofing a space between the inclosing brickwork and the column, of not less than 2 in., to be filled with liquid cement or grout; this brings the outer edges of the steel colums 10 in. from the outer face of the wall. In Seattle and Los Angeles but 4½ in. of brick, stone, tile, or concrete is required beyond the outer flanges of every column in the exterior walls. The fire risk in Newark and Louisville is probably the same as in Seattle and Los Angeles. The difference in thickness of the required fireproofing may be due to arbitrary assumptions on the part of the writers of the codes.

The New York code specifies that no part of a steel column shall be less than ¼ in. thick. Some cities that copy the New York code elsewhere require this thickness to be not less than ⅜ in. This required thickness of ⅜ in. is purely arbitrary. For the upper sections of columns carrying light loads it is not needed.

In designing plate-girders, the flange area is usually considered concentrated at the center of gravity of the flange and one-eighth of the web considered as a part of the flange. (The portion of the web is not always allowed.) In Detroit, plate-girders are to be figured by the moment of inertia of the net cross-section at the point in consideration. In Chicago and Seattle either method is permitted.

In Philadelphia for first-class buildings it is required that "where the bases of iron or steel columns are independent, the said bases shall be either cast-steel, thoroughly annealed, or built-steel bolsters. Built sections of girders or columns, in which all parts are not accessible after erection, shall be filled with concrete." This paragraph does away with cast-iron bases unless they are cast as a part of the columns, and also gives a preference to the use of plate-and-angle H-columns over box columns.

AMBIGUITIES IN CODES—Many codes are ambiguous in more or less important particulars. Two illustrations will be given.

Under Wind Pressure the New York code has the sentence, "In calculations for wind bracing, the working stresses set forth in this code may be increased by 50%. There is no excuse for phrasing a sentence so loosely. Is it intended that for the member under consideration the high unit-stress is applicable to the combined stresses due to wind and other loads or that the 50% increase is to be used for the wind stresses only? For a high and narrow building there is considerable difference between the two interpretations as to the amount of material required. The Chicago code removes all doubt, when it reads, "For stresses produced by wind forces combined with those from live- and dead-load, the unit-stress may be increased 50% over those given above; but the section shall not be less than required if wind forces be neglected."

In the Philadelphia code the formula for reduction of live-loads for office buildings is given as $X = 100 - \frac{1}{8}\sqrt{A}$. This quantity X is the percentage of live-load to be used, but as the required live-load for office floors in Philadelphia is 100 lb. per sq.ft., X becomes the actual live-load to be used per square foot of floor area. The quantity A is the *"area carried by any girder, column, or foundation."* In designing columns the question is at once raised as to what is meant by the "area carried by any column."

The writer has asked six engineers, each of whom he considered amply qualified to pass on the question, and has received two radically different opinions. (1) The first is that by A is intended the area of each single floor carried by the column. If the area was 300 sq.ft., X from the equation equals 86.1 lb. For a 12-story office building (12 floors), the load carried by the columns under the lower floor is $12 \times 86.1 = 1033$ lb. per square foot of ground area. This interpretation is the one generally followed in the designing of Philadelphia office buildings. (2) The second interpretation is that A should include the area of all floors carried by any column. For the 12-story office building mentioned above the equation for the live-load on the columns under the lower floor would read $X = 100 - \frac{1}{8}\sqrt{3600}$ or $X =$ 52 lb. per square foot of floor area, and as there are twelve floors the load would be $12 \times 52 = 624$ lb. per square foot of ground area. (3) A third opinion has been expressed, that the writer of the code intended a reduction of live-load similar to the New York code. This is, for the live-load coming to the column from the top floor the equation is, as before, $X = 100 - \frac{1}{8}\sqrt{300} = 86.1$; for the load coming to the column from the floor below the top, $X = 100 - \frac{1}{8}\sqrt{600} = 80.4$; for the second floor below, $X = 100 - \frac{1}{8}\sqrt{900} = 76$, and decreasing for each successive floor to the first floor, where $X = 100 - \frac{1}{8}\sqrt{3600} = 52$. The sum of the loads thus carried to the column by each floor equals 823 lb., the load per square foot of ground area carried by the column below the first floor.

A line or two in the code could easily have made clear just what was intended.

Working stresses are sometimes stated without indicating whether they are intended for gross or net section—an instance of carelessness in expression.

In some codes there are even more annoying omissions. Richmond, Va., while giving unit-stresses to be followed, makes no mention of loads to be carried. The building ordinance of Springfield, Mass., while stating loads to be carried, gives nothing whatever regarding working stresses to be used.

However, in justice to the writers of our building codes it should be borne in mind that no code can be written, or at least it has not yet been written, about which some questions of interpretation will not be raised. The familiar quotation, "The most perfect system of rules to insure success must be interpreted upon the broad grounds of professional intelligence and common sense," is applicable to a building code as well as to Cooper's *Specifications*. An instance of this came under the writer's observation a short time ago. In a proposed building were a number of steel columns made of four angles latticed. The designer finally changed the lacings to a solid web-plate, leaving the angles as they were. To his surprise this change was rejected by the building department of the city in which the building was to be located because it did not meet the requirement that no column should have a length more than 120 times the least radius of gyration. By taking out the web-plates and using lacings, the columns would pass the department.

In Portland, Oregon, a typewritten circular letter is issued "To Architects and Engineers" giving the "Method of Checking Work in the Building Inspector's Office." The opening sentences show its purpose and value: "This letter is written so that all may work on the same basis. It covers the principal points considered by this department in examining the engineering features of plans before issuing permits." The nature of the points considered may be inferred from the following paragraphs under the heading of "Beams":

Beams must be supported laterally, or the load reduced in proportion. Wooden joists will not be counted sufficient support for the flanges, unless secured in a manner satisfactory to the Department.

For short beams with heavy loads investigate for crippling of the web.

Beams under a solid brick wall may be figured as carrying a triangular portion of the wall only when there is ample brick beyond each end of the span to give bearing for the weight above. For walls with openings the total weight must be used.

While some of the paragraphs in this letter could well be embodied in the building law, the letter as a whole is admirable in removing doubt on many mooted questions. Its great value is stated in its object: "all may work on the same basis."

Conclusion

From the foregoing it will readily be seen that the need of revision in our building laws is quite general. The number of codes now being revised is evidence that this need is being felt by the public. Because one code differs from another is not in itself a cause for criticism. A code is, however, decidedly at fault when it contains absurd or needless requirements, or when its requirements are not clearly and definitely expressed. The eradication of these faults from every code in which they occur would be one great step towards uniformity. It would also be of great benefit if the municipal authorities or those to whom is intrusted the making of building codes sought outside their own bodies the advice of architects and engineers of established reputation. A provision is often inserted in a code without adequate knowledge of what it means. This comes from the author writing from a too limited experience, or on subjects with which he is not familiar.

Finally, public sentiment should be educated and led to a greater extent than it is at present by the engineering profession.

Studies at the Lawrence Experiment Station upon the Disposal of Sewage Sludge in Deep Tanks

By H. W. Clark* and G. O. Adams†

The first suggestion in regard to the retention of sludge in compartments separated from the main settling or septic tank, was made at the Lawrence Experiment Station in 1899,‡ and tanks constructed after this manner were operated there in that and the following years and have been described in the Lawrence reports. From this early Lawrence work, the Hampton tank of Travis and the so called Imhoff tank have developed. This was stated many years ago by Dr. Travis and more recently by Dr. Imhoff in a paper read last year before the International Congress of Demography and Hygiene at Washington.

The Imperial Patent Office of Germany in the case of Imhoff vs. Travis, more than a year ago, made the following statements regarding the claims presented in this case and quoted below:

Claim 1. Process for the biological treatment of sewage by means of separate treatment of the solid and liquid constituents characterized by the following: The sewage passing through one or more closed or open settling spaces at such a speed as to permit the lighter particles to come to the surface and the heavier to sink to the bottom and to pass through openings in it with a portion of the liquid into a liquefying space situated below the settling spaces, in which they are partly decomposed and liquefied through biological action, whence the liquid passes out of the liquefying space over weirs, etc.

Claim 2. Apparatus for carrying out Claim 1 characterized as follows: Combining the settling chamber (a) and the liquefying chamber (b) in a closed tank, etc.

These and other contentions of the various parties to this suit are long and need not be quoted here. The judgment rendered a year ago is also, like most judgments of this sort, exceedingly wordy. It states, however:

It need not be settled here whether these differences are material or not, as it is clear that compared with the purification plant described in the report of the Experimental Station at Lawrence of the State Board of Health of Massachusetts, Boston, 1899 (31st annual report, page 422) the protected process contains nothing new, which is contended by the claimant. The purification process there employed according to this report is exactly the same as that of the patent attacked. The sewage was passed through ordinary settling tanks and the sludge collected at its bottom was at the same time flushed into a septic tank, where alone it was subject to septicization. The defendants contend, however, from the fact that only ordinary settling spaces are mentioned in the Boston report, and that nothing is said about the continuous removal of the sludge out of the settling spaces, it must be concluded that the process described in the report was only worked intermittently and that a continuous flow through the plant as in the case of the patent attacked, had not taken place. **These contentions are, however, not justified, etc.**

Although this judgment was rendered more than a year ago exceptions were taken by the attorneys, and the case, I understand, is again before the Imperial Patent Office.§ Whatever the final decision, however, it is, of course, true that this separate compartment for the treatment of sludge was a Lawrence device, a description of which was published fourteen years ago.

In many published data in regard to the results of

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‡H. W. Clark—Report of Lawrence Experiment Station, 1899-1900, etc.

§Since the above was written, word has been received that an agreement has been reached by the parties to the suit and a compromise effected.

the Imhoff tank, claims are made that the sludge from tanks of this construction is more easily disposed of than sludge from ordinary settling and septic tanks, and that it is almost invariably odorless. While it is true that sludge from any sewage may under some conditions become odorless by long-continued bacterial decomposition whereby the organic and mineral matters are rendered of a humus-like consistency, it has seemed possible that the lack of odor noted in the sludge from many Imhoff tanks is due rather to the composition of the sewage entering these tanks than to the construction and operation of such tanks. Attention was called some years ago by one of us* to the fact that the sludge from the septic tanks at Birmingham, England, was odorless and the theory was advanced that this characteristic was due largely to the fact that large quantities of copper and iron salts entered the Birmingham sewage owing to the main industries of the city. Recently attention has been called to this, also, by Mr. Watson, engineer of the sewage-disposal works of Birmingham. Essen, Germany, where the Imhoff tank was first used, and the surrounding district are devoted to iron industries, and much iron must be present in the sewage.

Certain studies upon this subject of differences in sludge were begun at the Lawrence Experiment Station early in 1912, five tanks 17 ft. in depth being put into operation, each receiving sludge from a different sewage or sludge to which iron had been applied. These tanks are not claimed to be Imhoff tanks but seemed suitable for this study, and into each of them sludge was introduced through a pipe reaching some distance below the surface. This sludge when introduced contained about 97% of water.

SLUDGE TANK I—Beginning Jan. 17, Tank I received the sludge from Lawrence sewage, certain volumes being passed into the tank each week until the tank was practically full; this occurring on Apr. 5. After this date sludge was applied in certain volumes each week and samples for examination and analysis were taken from the bottom of the tank each month. Operating this way, it is probable that every sample taken from the bottom of the tank was of sludge that had been held within it for from three to six months, and during seven months this sludge was always of a lighter color than that applied, somewhat granular in structure but with a *very offensive* odor. There was comparatively little gas present and that present appeared to be insoluble rather than coming out of solution owing to decreased pressure, as described by Dr. Imhoff and others. Following this method of operation, a slight current of water was run into the bottom of the tank from time to time. This stirred the sludge slightly and soon after this treatment began all sludge drawn from the tank was odorless. It was also of a different texture than before this treatment and was easily drained.

SLUDGE TANK J was operated in the same manner and with sludge from Lawrence sewage but this sludge was precipitated with copperas and sodium carbonate. The average amount of iron in the sludge after treatment was 279 parts per 100,000, and calculated as FeO_2H_2, this was equal to 20.3% of the total solids present. The tank was filled slowly, as described under Tank I, and the first samples of sludge were taken from the tank on Apr. 5; after that date samples were taken for examination each month. The sludge entering the tank was black and frequently had the odor of hydrocarbons so noticeable when cast-iron is dissolved in acid, and on ignition, a considerable amount of SO_2 was given off. One sample contained 60.5 H_2S parts per 100,000, while the sludge from Tank I contained only 16.0 parts per 100,000. The sludge drawn from the tank was always viscous and *inoffensive* and after drying had a slight odor similar to that of stagnant pools.

SLUDGE TANK K was put into operation on Feb. 14, 1912, and received sludge from a tannery. This sludge contained a large amount of chemicals used in the processes carried on at this tannery, and when entering the tank it was black and *very offensive*. The tank was operated in the same manner as those described above, and all sludge drawn from the bottom of the tank was entirely *inoffensive*, without odor and so compact that when placed upon sand in an irregular pile, it would retain that form.

SLUDGE TANK L, put into operation on Mar. 22, 1912, received a sludge three-fourths of which was the same as applied to Tank I and the remainder precipitated with iron as supplied to Tank J. The amount of iron in this sludge was 112 parts per 100,000, and this calculated to FeO_2H_2 equaled 8% of its total solids. This tank was operated in the same way as those described previously, and the sludge drawn from the bottom of the tank from time to time was *slightly offensive*, but much less so than that from Tank I. In color, the sludge was darker than that from Tank I but not so black as that from Tank J.

SLUDGE TANK M was started on May 3, 1912, with sludge from the settling tank at the Andover filtration area. It was operated as were the tanks previously described, and the sludge was first drawn from it on Aug. 9. The sludge entering the tank and that taken from it were light colored and with exceedingly *offensive* odors. After seven months' operation, slaked lime was added to the accumulated sludge within the tank and a certain amount applied with that entering the tank. This treatment modified the odor but did not render the sludge inoffensive.

SLUDGE TANK N was started early in January, 1913, with sludge to which milk of alumina was added to make its alkalinity equivalent to that of the sludge in Tank J precipitated with copperas. Sludge drawn from this tank was *offensive* until active fermentation began, when the odor of the sludge was much modified.

SLUDGE TANKS O AND P were operated with Andover sludge. A small amount of air was pumped into the bottom of Tank O daily and water was run into the bottom of Tank P occasionally. Sludge drawn from these tanks was always *very offensive*; in other words, the Andover sludge in these tanks was not rendered odorless by a treatment similar to that which rendered the Lawrence sludge in Tank I odorless. Experiments upon the treatment of this Andover sludge with iron and further experiments with lime and milk of alumina are now being made, an experiments with tanks 30 ft. deep are also under way.

CONCLUSIONS—The experiments made with sludge in these tanks, 17 ft. deep, seem to show that sludge from certain domestic sewages may be offensive under all conditions of deep tank treatment except when containing iron or other metallic salts or an equivalent alkalinity;

*H. W. Clark—Some Observations of Methods, Cost and Results of Sewage Purification Abroad.

they also show that modification of the odor of some of the sludges was obtained by stirring this sludge with slight air or water currents.

The action of the iron, however, as a preventive of odors in the sludge applied to Tanks J and L is not easily explained. Its deodorizing effect might be supposed to be due to the fixation of sulphides by the iron. Other reasons appear to be equally applicable and are now being studied. Hydrogen sulphide was determined in all the samples of sludge drawn from the tanks, this determination being made by the addition of acid to the sludge, evolution of H_2S and its absorption in standard iodine solution. Omitting three high but apparently correct determinations during August, the average amount of hydrogen sulphide found in the sludge from each tank is shown in the accompanying table:

TABLE SHOWING AVERAGE PARTS PER 100,000 OF HYDROGEN SULPHIDE FOUND IN THE SLUDGE OF EACH TANK

Tank	H_2S
I	34.8
J	50.9
K	27.2
L	120.0
M	15.5

A Method of Removing Suspended Colloidal Clay from Drinking Water

In the May, 1913, issue of *La Technique Sanitaire & Municipale* of Paris, M. C. Doynel, who is Director of Water-Supply of the city of Sucre, Bolivia, described some experimental work in the investigation of a method of removing colloidal clay from the water-supply of the city of Buenos Aires, in which final success was achieved by mixing the muddy and soft river water with a certain proportion of hard water taken from some semi-artesian wells in the city.

The waters of River La Plata, which supply most of the water for the city of Buenos Aires, are heavily loaded, particularly at certain times of the year, with a finely divided colloidal clay which comes down from at least two of the tributaries of the main river. The water is taken about four miles above the city and is passed through a series of settling basins and slow sand filters to the main. The settling basins have a total area of about 10½ acres and the filter area is somewhat smaller. This supply amounts to 30,000,000 gal. per day and furnishes water to a population of about 500,000 people. The result of the filtration process is somewhat variable but fairly satisfactory. The bacterial count rarely passes 450 per c.c., and the hardness index is about 3°, which indicates a fairly soft water. The effluent is at all times potable, but it has invariably a decided turbidity due to the presence of the finely divided clay noted above. In times of flood the water becomes so turbid that the people and the press have lodged many complaints against it, the press particularly having organized a campaign in which the water is called "flowing mud."

Several different attempts were made to remedy this turbidity, but none of them were very successful. The Anderson process of precipitation by means of iron chippings, etc., placed in a revolving cylinder, was first tried as a subsequent treatment to the usual settling and filtration to which the water was subjected. While some improvement in the turbidity was noted, it was not sufficient to warrant the adoption of this device. The use of alum as a settling agent was suggested, but the engineer-in-chief of the plant would not allow its use as there was a very general sentiment in the city against the use of anything that might be classed as a drug. Somewhat later, however, alum was tried and also prefiltration, but no decided improvement in the amount of suspended clay was noted.

After all these experiments had been made, Mr. Doynel established the four following points as facts in the proposed clarification of the water, and used these facts as a basis on which to work further. The facts were: (1) That colloidal clay does not exist except when the hydrotimetric degree is low, that is, it exists only in soft waters; (2) in raising the hardness degree of water from 3 to 7 or 8, the clay commences a slow precipitation which allows its deposition on the slow sand filters through which the water passes; (3) it is necessary to use some reagent which will raise the hardness degree of the water. Any reagent which is inoffensive and will not leave a bad taste or color in the water could be used, but (4) on account of the popular antipathy in the city, no "drugs" (i.e., chemicals) could be used.

Acting on these basic principles, Mr. Doynel commenced to investigate the well water which is used in certain districts of the city. At a depth of about 100 ft. below Buenos Aires there exists a stratum where there is water which has no sensible current and has the additional peculiarity that the various wells sunk to it reach water of different chemical composition, which leads to the conclusion that the water is in various disconnected pockets. For instance, there is found at the same level and over a limited area water varying in hardness degree as much as 30°.

One of these wells was found having a hardness degree of 44, the hardness due principally to instable bicarbonate of lime. The experimenters assumed that if this water were mixed with the turbid river water it would produce sufficient hardness in the mixed water to induce the deposition of the clay. Experiments were made by mixing one liter of the hard water with ten liters of the turbid filtered water, leaving it to settle for 24 hr., and then filtering through filter paper. It has been found in the previous investigation that the filtered river water would still have a certain amount of clay after 20 filtrations through filter paper, but in the later studies it was found that the mixed water, which had a hardness degree of between 7 and 8, would have a satisfactory clarity after being passed through one filtering by filter paper. The result of a great number of these tests showed that the water company could mix 10,000 cu.m. of the hard water, having a hardness of 45°, with 100,000 cu.m. of the raw river water with a hardness of 3½° and procure as a mixture 110 cu.m. with a hardness degree of 7 to 8. After allowing this to settle 24 hr. and passing through the sand filters a clear, satisfactory effluent could be supplied.

On account of some difficulties connected with an attempt to get an Argentine patent on the process, the scheme was not installed, but instead clarification by the addition of aluminum sulphate is carried on during that part of the year when the turbidity is worse. Mr. Doynel states, however, that the results from this process have not been entirely satisfactory from a point of clarification.

Flood Destruction on the San Pedro Railway

By H. G. Tyrrell*

The worst cases of flood destruction on railways in America are those which have repeatedly happened in the arid states of Arizona and Nevada, and particularly that in Meadow Valley, a tributary of the Colorado River from the north. The railways in these states have usually been quickly built through districts where only scant particulars were obtainable in reference to maximum flood heights and conditions. In some regions of the West and Southwest, cañons or valleys which are normally either dry or carry very little water occasionally become raging torrents, and in these districts the greatest trouble has been experienced. These floods, together with the more recent ones in Ohio and Indiana, call special attention to the need of flood control and protection.

Conditions such as those just mentioned were met when building the railroad from Salt Lake City to Los Angeles, a distance of 784 miles. The need was evident for such a road to connect Los Angeles with the east, for, until then, travel had either passed around to the north, by way of San Francisco, or through Arizona to the southeast, either route being much longer than a direct line from Salt Lake across Nevada to the southwest.

The country at that time was very thinly settled, and valuable chiefly for its minerals, the surface being either sand or rock, and usually mountainous. But, notwithstanding adverse conditions for carrying on construction, the need for such a line was seen and its building was begun by Senator William Clark, of Montana.

When exploring the region for a prospective railway, the most likely route appeared to be that which had previously been followed by the Mormons and early pioneers when trekking southwest to California. Through Nevada this route followed the valley of Clover Creek and Meadow Valley, down through Rainbow Cañon until it emerged on the plains to the north of the present town of Las Vegas.

Through Meadow Valley in summer time, the stream is often not more than three or four feet wide and a few inches deep, and in some places the water sinks out of sight into the sand, and frequently little or no water is in sight for a year or more continuously. The cañon in some places is not over 50 ft. wide, but it widens out in other places to half a mile or more. It drains a rocky, mountainous region of over a million acres to the north, and sometimes in the winter or spring rapidly melting snow with rain converts the cañon into a torrent half a mile wide, and twenty feet deep in the narrow places.

Original surveys for the Clark railway were conducted by Charles D. Moore, of Salt Lake City, and in addition to the line through the cañon alternate courses were explored to the east and west on higher ground, one of the latter being recommended by him, instead of the uncertain low line through Meadow Valley. But the valley course with its shorter length and more uniform grades appealed to the directors, and it was therefore chosen in preference to the longer high line away from danger from floods.

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Floods of 1905 and 1907

In the spring of 1905, soon after its first completion, the road was damaged to the extent of $700,000 by floods, but was immediately repaired, through traffic being cut off for only two weeks.

Two years later, in March, 1907, a greater flood occurred, which put the road completely out of business for more than six weeks. Heavy rains and melting snow increased the little stream to a torrent, and in a single night damage was done to the extent of $2,000,000. The road for a hundred miles, from Barclay down to Guelph, was damaged, and 45 mi. of line was actually washed out and destroyed. A loaded freight-train was caught

Fig. 1. Sketch Map of San Pedro, Los Angeles & Salt Lake Ry. Line through Nevada

between two gaps, and part of it with its cargo went over the bank into the water. Many cars were lost and two or three engines badly wrecked. In some places where high banks had been washed away, the rails and connected ties still hung above the water like a suspension bridge, or if the connection failed they lay in tangled disorder in the valley or against the cañon walls. In other places, the rails were bent and twisted up by the current acting on the floating débris. Boulders 10 ft. in diameter, having their foundations washed away, were hurled down on the track. Wreckage was everywhere.

It took six weeks to get the line temporarily repaired so trains could pass over, and then the permanent rebuilding of the road was begun. At this time the writer was called in as bridge engineer, and the whole damage was examined in detail by him and the Chief Engineer. A combination office, sleeping and dining car and two

motor cars were used on the inspection trips. The writer personally examined and took measurements and notes of every damaged bridge, as well as photographs showing condition and position, with the contour of the surrounding country. These were all used in making a report on rebuilding, and the hundred or more photographs, a few of which are shown here, were especially serviceable.

Almost all the bridges on the road were timber trestles with gravel decks. Against these had often collected floating trees and wreckage of other bridges, and so dammed the water as to to cause their destruction. Their

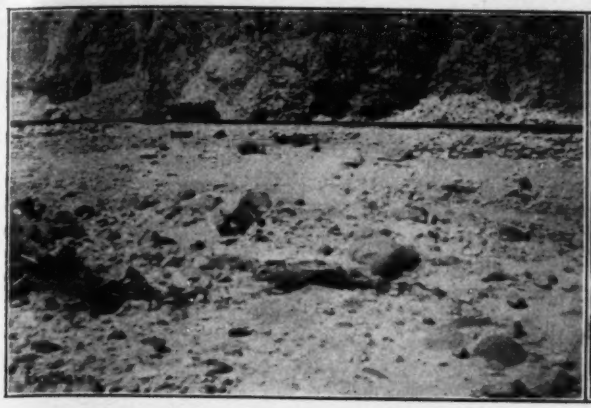

FIG. 2. VIEW FROM ONE CAÑON WALL TO RAILWAY LINE CLOSE ALONG OPPOSITE WALL. RIVER BED DRY

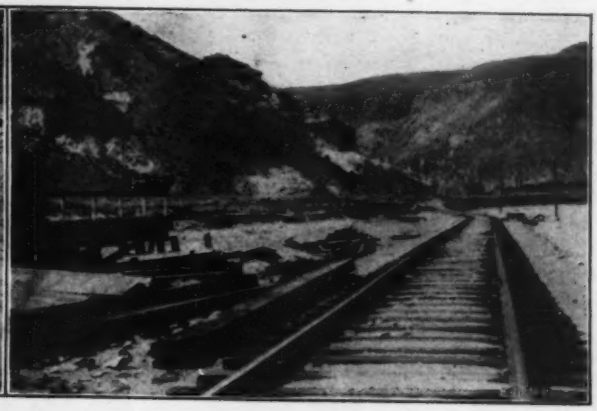

FIG. 3. TEMPORARY TRACK ON DRY RIVER BED, AROUND WASHOUT OF EMBANKMENT AND TRESTLE

FIG. 4. SCOUR IN CHANNEL. BANK AT RIGHT IS NEW, HAVING BEEN ALL WASHED OUT

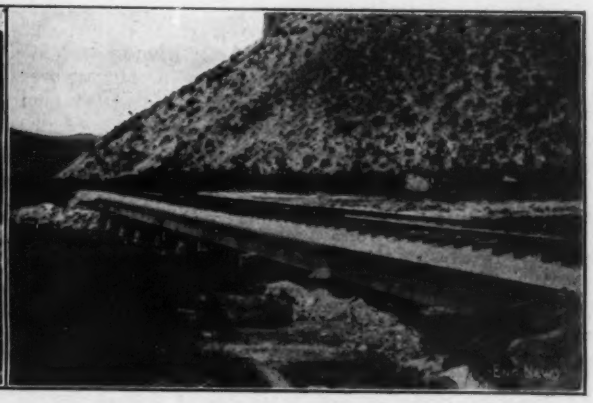

FIG. 5. TYPICAL TRESTLE. NOTE SMALL UNDERCLEARANCE IN ORIGINAL CONSTRUCTION

FIG. 6. TRESTLE TOO LOW FOR FLOODS. RIPRAP AT RIGHT FOR BANK PROTECTION. VIEW SHOWS ONE OF THE FEW GROVES ALONG THE LINE

FIG. 7. TEMPORARY TRESTLE AT WASHOUT. BANK AT RIGHT RIPRAPPED FOR PROTECTION AGAINST FUTURE FLOODS

FIGS. 2-7. VIEWS IN MEADOW VALLEY WASH, NEVADA, AFTER THE 1907 FLOOD

position and length, which had been determined by guess or judgment, was often far from that required to safely pass the floods, and in rebuilding, the position and lengths were changed in many cases. A great number of trestles were required on account of the winding course of the stream in the broader stretches of the valley. In rebuilding the road, an extensive system of channel changes was carried out, and 18 trestles were eliminated; in other places, where river crossings could not be avoided, steel-truss bridges were installed. In nine different places through the 45 miles of washout the river was diverted into a new channel, and this work involved the excavation of 100,000 cu.yd. of earth and 120,000 cu.yd. of rock. Where the valley narrowed to a cañon, the contracted channel was made proportionately deeper to carry the flow, and in some places, where the track was laid in the old river channel, high rock cliffs were blasted out to make a watercourse.

The track was elevated on banks which were thought to be high enough for safety, and wherever exposed to wash these banks were heavily protected by riprap. No less than 16 miles were thus guarded with stone facing, requiring 230,000 cu.yd. of stone, much of which was handled by a car derrick and set in place by hand. The facing was run out 4 ft. from the toe of the slope under the stream, and built up 2½ ft. above the last high-water mark, the usual height being 7 to 8 ft. This riprap alone cost the company about a million dollars.

The whole work of repairs was one of the biggest ever carried out in America, and occupied about 1000 men for nearly two years, costing approximately $33,000 per mile. When repairs were completed, very triumphant boasts of its security were made in some of the papers, some of them reading as follows:

> Today the railroad runs through the cañon, forever safe from the ravages of storm. That roadbed is laid to last for all time, and to defy not only the annual winter rise of Meadow Valley Creek, but to set at naught the torrents which unexpected cloudbursts send rushing down from the surrounding ranges.
>
> The water of Meadow Valley Creek is held in bounds by man-made walls of stone, which no force short of an earthquake can dislodge.
>
> Gone is its battle cry, gone is its song of triumph, for the men of the transit and rod have conquered.
>
> An earthquake might hurl these bridges from their places, but it could never wreck them.
>
> At no time, even though the amount of water carried in the Wash exceeds that carried at any previous time in the knowledge of man, can it overflow the new banks.

But it was not long before the folly of these boasts was proven. Repairs from the second washout had been completed only a few months, after two years' work, when the third washout came, by far the worst of all. This one has been declared to be *"the worst railway calamity in America"* and the statement is doubtless true.

The Flood of 1910

On the early morning of Jan. 1, 1910, when the whole country around was covered with 18 in. of snow over frozen ground, a thaw came with a warm wind, followed by heavy rain. The whole snowfall was melted in a few hours, and, being unable to sink into the frozen ground, it ran off with a rush and caused the flood. Five times as much water went down the valley as three years before, and in some places the river was 12 ft. deep over the tracks. The damage began at Barclay, just west of Crestline, and continued clear down to Rox, a distance of over 75 miles, though the track was cut off for 93 miles.

The flood and destruction were worst at Caliente, and a train of passengers was held just west of Caliente for five days, the track being washed out at both ends. On Jan. 10, twenty of the travelers were taken by wagon to Acoma. A Pullman car porter stayed there for a month, but for several months following, the whole train was abandoned to the care of a single watchman. Freight cars were also caught in the Caliente yards, and a train of 26 cars was ditched. The disaster caused 600 men to be laid off, awaiting road repairs.

The estimated flow at the time of freshet was 50,000 sec.-ft., which would require a channel area of over 5000 sq.ft., or 250 ft. wide by 20 ft. deep. Water was actually 8 ft. deep over the bridge decks in some places.

The flood of 1905 had cut off travel for two weeks, and that of 1907 for six weeks, but this time no through trains were run for more than four months. The fast express which left Los Angeles on Dec. 31, 1909, did not arrive in Salt Lake City until May 17, 1910, after 137 days.

When the water had all run off, the scene in the valley was one of desolation and ruin. Everywhere were trees and timber from the wrecked wooden trestles, with occasional barrels, remains of cars and other débris. As material had floated down against a bridge, it would so dam the flow as to wash the bridge away, and each one washed out would only make the destruction of the next one more certain.

The work of rebuilding was at once begun. Surveys were made for high lines to the east and west, following the course which had been outlined a few years before, but these lines were longer and more hilly than that in the valley. The cañon is also a more picturesque route, with a more uniform grade, and it was, therefore, selected again for the rebuilding. The track was elevated well above the reach of water, often lying against the cañon side.

The track originally crossed the stream 85 times, on timber trestles. In rebuilding, 61 of these were avoided by means of channel changes, and the remaining 24 bridges were replaced in steel. These bridges are in two spans, with concrete abutments and center pier, having a total aggregate length of 4900 ft. Ten tunnels were also built, ranging in length from 300 to 1300 ft., their aggregate length being 6000 ft.; some of these were built at the rate of 15 ft. per day.

The rebuilding of the 76 miles consumed thirteen months, and cost upwards of $10,000,000.

All the illustrations herewith shown were made by the writer after the second flood, when bridges were being examined with a view to replacing them. At that time I reported and insisted that bridges were not desirable, and recommended rebuilding the line on high ground away from danger of flood. But in this matter the recommendations of both Bridge Engineer and Chief Engineer were overruled, and the line at its second rebuilding was constructed in the valley bottom as before, only to be destroyed again, as just described.

✖

Statistics of Passenger Casualties on the Pennsylvania R.R. lines east of Pittsburgh shows that in the five years from 1908 to 1912 inclusive, there were 481,000,000 passengers carried and only five train accidents in which passengers were killed. The total deaths in these five train accidents numgered 16, so that on this portion of the Pennsylvania System one passenger was killed in a train accident for every 30,000,000 passengers carried.

The Use of Hydraulic Lime for a Masonry Dam*

By GUY S. NEWKIRK†

Near Santa Rosalia in the state of Chihuahua, Mexico, the Mexican Northern Power Co. is creating a large reservoir by the construction of a high masonry dam, the site of which is in a short cañon of the Conchos River, known as La Boquilla. On account of the topographic formation, it was found necessary to build an auxiliary dam across a depression in the ridge. This dam is known as "Tiger Hill Dam," and is situated about a mile distant from the main dam. The main dam is being built of portland-cement concrete, but owing to high-transportation costs, it was decided to build Tiger Hill dam of hydraulic-lime masonry, preliminary tests of the available material having shown that a good grade of hydraulic lime could be produced; there being an abundance of limestone at the immediate site and clay at a short distance.

The total length of the dam is 2410 ft., and the maximum height 90.2 ft., with an average height of 69.1 ft. The original plans called for a height of 73.8 ft., but later it was decided to raise the dam 16.4 ft. The foundation is a well compacted clayey soil. The top surface was excavated to a depth of about 20 ft., and in this trench was laid the foundation of hydraulic-lime concrete 3.8 ft. thick, also a toe wall at the up-stream face, of the same material. On this foundation is laid the masonry, which is of limestone rock laid in mortar.

PREPARATION OF MATERIALS

There are two methods of preparing hydraulic lime. One is to take the proper proportions of limestone and clay, grind them together, then moisten the mixture and mold into blocks or balls. These blocks are then burnt at a temperature of about 1000° C. The burnt product is then slaked and is ready for use. This is known as the dry process. The other method, termed the wet process, is the one most generally employed, and is used on this job. In this process the limestone and clay are burnt separately and reduced separately to powder before mixing. This process has the advantage in requiring less grinding of the raw materials and less care is necessary in the firing.

LIME—Limestone is obtained from a quarry at one end of the dam, located at a slight elevation above the lime kilns, thus enabling the cars to run by gravity to the top of the kilns. The latter are of circular construction, built of rock and lined with firebrick. Coal is used for fuel. The burnt lime is wheeled to a platform near the kiln, spread out in a layer from 6 to 8 in. thick and slaked. The slaked lime is then shoveled through an opening at one end of the platform, which leads by means of a chute to a revolving screen made of sheet metal containing ½-in. slots. The screen is equipped with hinged hammers inside to facilitate the passing of the material through the screen.

CLAY—Clay is obtain from a deposit near the river, about half a mile below the main dam. The color when dry is a light slatey color and changes to almost black when wet. Small basins are dug at various places in the deposit and water is conducted to these basins by means of small ditches. When sufficient water has been introduced into the basin the flow is shut off and the clay is then worked up with hoes into a wet plastic mass. This is then taken to the surface in wheelbarrows where it is shaped by hand into balls of from 5 to 6 in. in diameter. These balls are placed in rows on the ground and left exposed to the sun until dried. Under favorable conditions the drying takes place rapidly, 24 hours being sufficient in the warm summer days, but during bad weather several days are required.

After the balls have been thoroughly dried they are burnt to a salmon tint in circular kilns. Tests have shown that this degree of burning gives better results than a red (well burnt) or a black (under burnt) clay. The kilns are built of sun-dried adobe brick and lined with firebrick. The kilns are 7 ft. in diameter and 14 ft. high. For draft and discharging, a 4-ft. square opening is left at the bottom of the kiln. The supporting bed for the charge is made of old railroad rails spaced so that firebricks will just fit between the head and base of the rails. These bricks are placed before the kiln is charged and can easily be removed after the burning is completed, thus enabling the burnt balls to fall to the bottom of the kiln, from which they are shoveled onto a pile near-by.

The grinding of the clay balls is accomplished by means of a 5x22-ft. tube mill. The balls are loaded by hand from the piles into wheelbarrows and wheeled to a platform surrounding the feed hopper of the mill. Here the balls are crushed by hand by means of wooden mauls. The crushed material is then shoveled into the hopper of the mill. Two men are required to do the crushing and one to shovel the material into the mill.

The pulverized product is then discharged from the other end of the mill into dump cars. The output varies from three to five carloads, of one cu.yd. capacity per hour. Care is taken to exclude all clay from entering the mill which is damp, as the moist material tends to clog up the discharging plates.

The charge of pebbles for the grinding is somewhat less than half enough to fill the mill. They are round stones, varying in size from 3 in. to 6 in., gathered from a near-by gravel deposit. As they are composed mainly of limestone they wear away very quickly and require renewing every week. The clay is well pulverized, having a fineness averaging 89% through the 200-mesh sieve and 98% through the 100-mesh sieve. The cars of clay are hauled to the mixing plant by a narrow-gage electric railway, and the clay is stored in bins near the mixers.

SAND—The sand is obtained from a deposit of sand and gravel in the river. The material is loaded into cars and hauled to a separator, where the sand and gravel are washed and separated. This washer also furnishes sand and gravel for the main dam. The sand is hauled to the mixing plant and piled near the mixers.

MIXING

The mixing is done by six pug mills, driven by electric motors. Each pan has a capacity of 7 cu.ft. The mills are placed in a row on stone piers, so that they may be discharged through a door in the bottom of the pan into cars below.

The material for each charge is measured by loading it into wheelbarrows of uniform size, care being taken to secure proper loading of the same. The charge for the mixer is dumped on a small platform in front of each mixer and then shoveled by hand into the pans.

The most satisfactory method for charging is as follows: The water valve, which is connected to each pan, is opened, then all the lime shoveled in, followed immediately by the sand, then the clay. The workmen soon learn by experience how much water to give to a batch for the proper consistency. The consistency used is a rather stiff mixture, so that the rollers produce a grinding action and thoroughly grind the materials together. A wetter mixture gives poor results because the material flows in front of the rollers and the ingredients are not well incorporated.

At the beginning of the work the time of mixing was 15 minutes for each batch, but later the time was shortened to ten minutes. Still later investigations were made and showed that no material difference in strength occurred when the time was reduced still more, and so the time was reduced to five minutes, which time is used at the present stage of the work. This does not include the time of charging and discharging, but the actual time in the pan.

At the beginning of the work the ratio used was one of lime, two of clay, three of sand, for the masonry mortar, and one of lime, two of clay, for the paste for concrete, the paste being then mixed with three parts of unsifted gravel containing about 50% sand. A few months later the ratio of material was changed from 1:2:3 to 1:1:3, in the mortar, and from 1:2 to 1:1, in the concrete paste. This change was made because of the shrinkage of the former mixture, which caused fine hair cracks to appear at some points in the work. Actual laboratory tests of the shrinkage gave for the 1:2:3, 0.84%, and for the 1:1:3, 0.43%. Tensile tests had shown that, while the 1:1:3 mixture is somewhat weaker than the 1:2:3, it develops ample strength for the work. Later results show that there is very little difference in the strength after three months.

METHOD OF CONSTRUCTION

From the mills the mortar is taken in dump cars to the work. A timber gantry was built adjoining the vertical face of the dam, and the material is conducted on a track on this gantry to the required location.

In placing the concrete foundation, the trench was divided into sections varying from 15 to 25 ft. in length. Alternate sections were filled and allowed to set. The forms were then removed and the remaining sections filled. During the warm weather the forms may be removed in three days, but the colder temperature retards the setting and from five to six days were found necessary for sufficient setting.

In the earlier stages of the work the concrete consisted of a mixture of one part paste to three parts of unsifted gravel as stated above, later the mixture was changed to one part of 1:1:3 mortar to 2½ parts of broken stone.

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*From "Journal of Engineering, University of Colorado," No. 9, 1912-13.

†Assistant Cement Tester and Inspector, Mexican Northern Power Co., Santa Rosalia, Chih., Mex.

The mixing of the stone with the paste or mortar was done by hand on a platform above the point of deposit. The proper proportion of stone was measured in a measuring box and spread out in a layer, then sprinkled with water from a hose; the mortar was then spread on the stone and the mass mixed with shovels and hoes.

The rock used for the masonry is limestone of irregular shape and size, the size varying from spalls to stones requiring two men to handle. No stones too large for two men to handle are used, owing to the difficulty in placing.

In laying up the wall the stones are placed as close as possible and all large openings are filled by pushing spalls into the mortar.

The entire work is under the supervision of inspectors, who see that the material is properly mixed and placed.

The finished masonry is continually watered to prevent the mortar from drying out before it sets.

LABORATORY TESTS

Before commencing the work on the dam, laboratory experiments were made with various mixtures to determine the proper proportions, with the result that the above mentioned mixtures were used.

Careful tests are made in the laboratory of each day's mixture. Samples are taken directly from the mills and also the concrete. Standard briquettes are made of each day's sample of mortar, and 6-in. cubes for compression tests, of the mortar and concrete.

The mortar coming directly from the work is as a general rule too wet for immediate placing in the molds and is allowed to stand for a few hours, and the excess water which rises to the surface is poured off.

The mortar is gently rammed into the molds by means of a light brass rod, in order to insure the complete filling of the molds and elimination of all air bubbles.

The briquettes are placed in a damp closet. At the end of 24 hours the molds are removed, the briquettes being kept for a further 48 hours in the damp closet, then placed in water. The water is kept as near as possible at a constant temperature of 70° F. as experiments have shown that cold water retards the setting.

The specimens for compressive tests are molded into 6-in. cubes. The cubes are kept in the molds for three days, and two more days in air, then placed in water.

Tensile breaks are made at intervals of 7 days, 28 days, 3 months, 6 months, 1 year and 2 years, three briquettes are broken at each test. At the present time of writing no 2-year breaks have been made. The first compression breaks are made at the end of 28 days. The accompanying table shows the summary of the tension and compression results.

SUMMARY OF LABORATORY TESTS

	Proportion of material vol.			Time of	Tensile strength, lb. per sq.in.				
Material	Lime	Clay	Sand	mixing	7 days	28 days	3 mo.	6 mo.	12 mo.
Mortar	1	1	3	5 min.	34	102	199	242	250
Mortar	1	2	3	15 min.	60	152	213	234	256
Mortar	1	2	3	10 min.	58	148	208	238	273
Mortar	1	2	3	5 min.	46	150	215	246	279

COMPRESSIVE RESULTS

	Proportion of material vol.		Compressive strength, lb. per sq.in. (6-in. cubes)			
Material	Mortar	Stone	28 days	3 mo.	6 mo.	12 mo.
Mortar	1 : 1 : 3	...	335	690	862	788
Concrete...	1 (1 : 1 : 3)	2.5	144	298	307	...

Note.—The 12 months' results are low, due to the fact that the cubes were kept in air for the first six months.

CONCLUSIONS

The use of hydraulic lime for this job has proved to be very satisfactory. The appearance of the finished work is good, the concrete being dense and sound and the masonry solid and well joined.

One of the advantages of hydraulic lime for this class of construction, besides being much cheaper than portland cement, is that it sets slow, which enables the surface to be worked up again after standing for a day or two, without any loss in strength, so that there is no imperfection of bond with the next course. Also the settlement is much slower than portland cement and consequently there are fewer internal strains.

⁂ ⁂

Abstracts of Testing Materials' Papers

SYNOPSIS—We give below extensive abstracts of four papers presented at the Sixteenth Annual Meeting of the American Society for Testing Materials, held at Atlantic City, N. J., June 26-28. An account of the meeting appears on a later page of this issue.

⁂

The Application of Specifications*

By Robert W. Hunt†

In the not distant past there was a more or less general feeling among the manufacturers of this country that specifications covering their products were entirely unnecessary. If it amused a customer to formulate such things and present them as describing that which they desired to purchase, well and good, but that the products should actually conform to the details of what they considered purely academic requirements, was a different proposition. They had been for years engaged in their several occupations and naturally knew more about them than was possible for any outsider. In a way, this was true, but the element of progression was involved, with the result that what had been equal to, and, therefore, satisfactory, under the requirements of yesterday, became inadequate to the demands of today; and the situation could be best met by accurate observations of the behavior of materials of known composition under carefully observed conditions and measured stresses, and it is patent that without complete knowledge of observed materials, the obtained results would be so obscured that accurate deductions would be impossible. In many cases, the conditions under which materials are to be used are so widely different, that what would be satisfactory in one case, would be very unsatisfactory in another.

With the progress of affairs, and, in fact, as part of such progress, has come the organization of technical societies. They have played and are filling an important part in the world's scientific and material advancement. The societies dealing with production and application of materials and power have brought together the brightest minds and most enterprising of the world's workers, who have, quicker and more thoroughly than would have been in any other way possible, found that no matter how smart each man might be and how much he might know, it would not be all, and that, through comparing notes and so exchanging knowledge with his fellows, he was certain to ultimately receive at least as much as he gave. That such is true is now accepted, and the day of closed shops and self-sufficiency forever passed. With this has also come the day of specifications, but, as yet, let them be drawn ever so carefully, and based on the most careful observation, they cannot entirely take the place of and make unnecessary the exercise of initiative on the part of the producer. Specifications have to be not only adapted to the conditions under which the materials are to be used, but they also have to be intelligently applied to the production of the materials they are intended to cover. They must be kept practical. There is no question that steel absolutely without any phosphorus in its composition would be most desirable, but, so long as such metal is practically unattainable, why specify it? And knowing that the available iron ores of a country are best

*Presidential address before 16th annual meeting of the American Society for Testing Materials, Atlantic City, N. J., June 24, 1913.

†President, Robert W. Hunt & Co., Chicago, Ill.

adapted to certain processes, it would seem unwise to expect their engineers to adopt specifications which would leave their own people out of the running.

It is thought by many that one of the most desirable results of the International Association for Testing Materials and its Congresses, will be the adoption of International Specifications. It is only in a somewhat restricted degree that I concur in that view. I think that for many years to come most countries will demand specifications which will best apply to their own circumstances either of production or use, or both. While, for instance, Germany is a large and successful producer of basic bessemer steel, it has been proven by two costly failures that the ores of the United States are not adapted to the economical production of such steel; therefore, this country cannot be expected to have much interest in international basic bessemer steel specifications. Still, adhering to my own shop, it is patent that so long as European railways have their present light equipment and short lines, they will not require the same character of rails as our American roads; nor do they need the same details for their equipment. There are many other instances in which different countries will, for their own use, require different specifications, no matter where the products may be made, but there is one international field on which all countries can unite, and that is in the studying and discussion of scientific investigations and the details of the testing of materials, and, on the results thus obtained and mutually discussed, valuable specifications can be based. To be of value, they cannot be purely academic, and bringing into personal contact the scientist and the intelligent practitioner is certain to result in real progress.

Probably as much attention has been given in this country to specifications for steel rails as for any other product. Three of the national technical societies have had able committees upon the subject, and it has received at their hands years of careful investigation and consideration. The present Rail Committee of the American Railway Engineering Association is composed of some of the ablest railway engineers of this country, and they have had placed at their command facilities for observation and money for experiment, and the steel-rail specifications approved by them are generally accepted by the American railway world as being *ex cathedra*; but that they, if blindly followed, will not insure satisfactory products has lately been most strikingly illustrated. Their specifications provide that if, under certain conditions, the drop test piece which is to be taken from the top end of the top rail of the ingot fails, all of the top rails from that heat shall be rejected, and a second test shall then be made of a test piece cut from the top end of any second rail of the same heat; and if that piece fails, all the second rails of the heat shall be also rejected, and a third test made from a top piece taken from any third rail of the heat; and if it also fails, all the remainder of the rails made from that heat shall be rejected.

It occurred lately that on an order for rails under the above named specifications, a large percentage of the top rails failed, about 22%, and about 20% of the test pieces from the second rails of those same heats also failed, and about 40% of the third rails tested from that 20% also failed, and, therefore, the entire heats represented by these last rails were condemned. The chemistry of all of the steel was clearly within the specifications, and, under a strict interpretation of them, only the top rails of the failed heats plus the second rails of heats whose second rails also failed, plus the entire heats represented by the failed third rails, would have been rejected; but with steel giving such a heavy percentage of unsatisfactory results, and realizing that, at best, the tested pieces were but a small proportion of all the metal represented, it was decided not to ship any of the rails which had been rolled on the order; which, in my judgment, was a wise nonadherence to the letter of the specifications. But such instances do not at all prove that specifications are without value. They afford an available means of formulating the most advanced state of the art, and, if drawn according to the best judgment of men familiar with the practical workings of that art, they will be to the highest interest of both producer and user.

The Action of Various Substances on Cement Mortars*

By Richard K. Meade†

The following experiments on the action of various substances on cement mortars were begun some five or six years ago, about the time that the agitation over the destruction of concrete by the alkaline waters of the West was first started, and were undertaken not only to see if such action was really likely to take place, but also to determine which of the salts ordinarily found in ground waters were the cause of such destruction.

The salts usually found in the so called "alkali waters" of the West are also those which occur in sea-water and are those present in largest amounts in many spring and river waters. They are sodium chloride, magnesium sulphate, calcium sulphate, sodium sulphate and sodium carbonate. In order to test the effect of solutions of these substances on cement mortars, a sample of normal Lehigh Valley cement was selected and from it a large number of sand briquettes were made.

Analysis and tests of the cement are given in Table I.

TABLE I. ANALYSIS AND TESTS OF THE CEMENT EMPLOYED

ANALYSIS

Silica	20.20%
Oxide of iron	2.50
Alumina	6.96
Lime	62.40
Magnesia	3.01
Sulphur trioxide	1.60
Loss on ingnition	2.38

PHYSICAL TESTS

Soundness

Steam	O. K.	Cold water	O. K.
Boiling	O. K.	Air	O. K.

Fineness

Passing No. 100	94.3%
Passing No. 200	77.8

Setting Time

Initial set	2 hr., 15 min.
Final set	6 hr., 30 min.

Tensile Strength, Lb. per Sq.In.	Neat	Sand
1 day	315	...
7 days	765	245
28 days	875	340
3 months	885	415
6 months	885	435
1 year	890	510

All briquettes were made from a mixture of one part cement and three parts standard Ottawa sand. They were allowed to harden 28 days in air and then immersed in a solution of the salt. The briquettes were piled in such manner that the solution had access to almost their entire surface.

The solutions in all cases except that of the calcium sulphate, which was a saturated solution, were made up of one part of the salt to 100 parts of water, to form practically a 1-per cent. solution. At first the solution were changed every few days, but after the first month the solutions were changed weekly and after the first year less often. The results obtained are given in Table II.

*Paper presented to the 16th Annual Meeting of the American Society for Testing Materials, Atlantic City, N. J., June 26, 1913.

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TABLE II. ACTION OF VARIOUS SALTS ON CEMENT MORTARS

Age in solution	Tensile Strength, lb. per sq.in., after immersion in Magnesium sulphate	Magnesium chloride	Calcium sulphate	Sodium sulphate	Sodium chloride	Sodium carbonate
0 days[1]	219	219	219	219	219	219
7 days	268	245	227	257	236	225
28 days	272	300	300	334	268	277
3 months	287	315	334	354	299	324
6 months	196	202	314	378	287	320
1 year	Disintegrated	115	209	271	310	337
2 years	...	Disintegrated	Disintegrated	141	325	360

[1] The briquettes were aged 28 days in air before immersion.

First it should be remembered that the 28-day strength of briquettes kept in air is much less than that of those kept in water. As will be seen from the results given in Table II, the sulphates have a marked action on concrete, which seems to be most apparent in the case of the magnesium salt. The action of magnesium sulphate on cement mortars has been discussed quite voluminously of late and I will not go into it to any length in this paper beyond stating that we carefully analyzed the affected portion and the unaffected portion of a sand briquette which had been stored in a solution of magnesium sulphate. These analyses are given in Table III.

TABLE III.

	Before immersion	Unaffected portion	Affected portion
Silica, per cent	75.12	73.96	69.40
Oxide of iron, per cent	0.52	0.60	0.30
Alumina, per cent	1.15	1.30	0.64
Lime, per cent	14.80	14.50	14.21
Magnesia, per cent	0.70	1.66	3.64
Sulphur trioxide, per cent	0.33	0.83	5.78
Loss on ignition, per cent	7.02	7.14	14.97

The large increase in the magnesia and sulphur trioxide and the decrease on the oxides of iron and alumina indicate the elements which react with each other. The loss in silica may be due to chemical action also, but as the surface of the briquettes was very much attacked and the sand grains could be scraped away with the finger, I am inclined to think that the lower silica in the disintegrated portion was probably due to mechanical causes rather than chemical action. It will be noted that in almost all cases the first effect of the solution was to increase the strength of the briquettes and that signs of disintegration in no cases became evident until after a period of three months in the solution.

Some of the briquettes were even boiled in a 5% solution of magnesium sulphate for several days, and in all cases the briquettes were much stronger after boiling than they were before and fully as strong as briquettes boiled in pure water, showing how slow the action of the sulphates is.

The briquettes which failed were considerably swollen and presented much the appearance of a baked potato which has burst its jacket.

Various authorities have proposed at different times the use of divers ingredients in concrete exposed to sea-water, with a view to their reacting with the salts of the latter to form insoluble compounds which would protect the concrete. Most persistently suggested of these are the salts of barium, which form with soluble sulphates insoluble barium sulphate. I tried both barium chloride and barium carbonate. These were ground very finely and mixed with the cement. I employed 2% of barium chloride with the cement, and also 2% and 5% of barium carbonate. Sand briquettes were made from these mixtures and the test pieces stored in a magnesium-sulphate solution containing 10 grams of the salt to the liter. The results are given in Table IV, and, as will be seen, none of these compounds arrest the destruction.

TABLE IV. ACTION OF MAGNESIUM SULPHATE ON CEMENT MORTARS CONTAINING BARIUM COMPOUNDS

Age in 1% solution of magnesium sulphate	Tensile Strength, lb. per sq.in., of briquettes containing 2% of barium chloride	2% of barium carbonate	5% of barium carbonate
0 days[1]	181	115	166
7 days	...	221	257
28 days	213	246	346
3 months	306	311	346
6 months	265	204	274
1 year	146	Disintegrated	Disintegrated

[1] The briquettes were aged 14 days in air before immersion.

Some years ago an English chemist suggested the use of finely ground, burnt red brick as an admixture for concrete which was to be used in sea-water. After reading this paper it occurred to me that the resistance to sea-water claimed for high-iron cements might be due to the presence of oxide of iron in the cement. I therefore had sand briquettes made up containing oxide of iron in various forms and conditions, namely, red or ferric oxide, magnetic oxide of iron, venetian red (an impure oxide of iron made from low-grade iron ores, so called "paint ores" of the Lehigh district), and finely ground red brick, using of these 5% of the weight of the cement in each case and placing the briquettes in a 1-per cent. solution of the magnesium sulphate. The results are given in Table V. As will be seen the additions of iron compounds are in no way beneficial to cements to be employed in sea-water.

TABLE V. ACTION OF MAGNESIUM SULPHATE ON CEMENT MORTARS CONTAINING IRON OXIDES, ETC.

Age in 1% solution of magnesium sulphate	Tensile Strength, lb. per sq.in., of briquettes containing 5% of Ferric oxide	Magnetic oxide	Venetian red	Brick dust
0 days[1]	218	225	165	170
7 days	275	280	225	220
28 days	310	340	300	275
3 months	355	340	345	310
6 months	310	280	215	205
1 year	125	105	Disintegrated	Disintegrated

[1] The briquettes were aged 14 days in air before immersion.

I next tried waterproofing the mortar on the theory that if the circulation of water through the pores of the mortar could be stopped no chemical action could take place. I employed for this purpose both a high-calcium and a magnesian-hydrated lime, road oil (as recommended by Page), a mixture of silicate of soda solution and fish oil (a well known waterproofing compound), and lime soap (the basis of many waterproofing compounds). I also tried dipping the briquettes first in a hot solution of soap and then in one of alum (Sylvester's Process). The results of the tests of sand briquettes made from these mixtures and stored in magnesium-sulphate solution (10 grams to the liter) are given in Table VI.

TABLE VI. ACTION OF MAGNESIUM SULPHATE SOLUTION ON SO CALLED WATERPROOFED MORTARS

Age in 1% solution of magnesium sulphate	Tensile Strength, lb. per sq.in., of briquettes containing 15% of hydrated lime (calcium)	15% of hydrated lime (magnesian)	10% of road oil	2% of lime soap	2% of oil-silicate soda	Treated with alum and soap
0 days[1]	215	215	165	185	160	220
7 days	215	225	200	210	200	235
28 days	315	320	210	250	245	275
3 months	245	260	260	275	260	265
6 months	200	245	210	230	225	215
1 year	120	105	140	180	165	185

[1] The briquettes were aged 14 days in air before immersion.

It will be noted that, while the disintegration is evidently taking place in these test pieces, all of these compounds seem to arrest it to some extent at any rate, and in the case of the lime soap and Sylvester Process this is quite marked.

I also investigated the action of magnesium-sulphate solution on cements high in silica. For this purpose, samples of commercial cement, one high in silica and low in alumina and one low in silica and high in alumina, were selected; sand briquettes were made of these and immersed in a solution of magnesium sulphate containing 20 grams to the liter, or practically a 2% solution. The cements selected had the following analyses.

	Per cent. Low-alumina cement	High-alumina cement
Silica	23.24	19.86
Iron oxide	2.25	2.56
Alumina	5.03	7.60
Lime	63.55	63.12
Magnesia	3.05	3.10
Sulphur trioxide	1.51	1.66

As will be seen from Table VII, the low-alumina cement resists the action of magnesium sulphate much better than the high-alumina one.

TABLE VII. ACTION OF MAGNESIUM SULPHATE SOLUTION ON HIGH AND LOW-ALUMINA CEMENTS

Age in 2% solution of magnesium sulphate	Tensile Strength, lb. per sq.in., of High-alumina cement	Low-alumina cement
0 days[1]	242	225
7 days	318	307
28 days	404	430
3 months	402	476
6 months	230	472
1 year	Disintegrated	500
2 years	...	425

[1] The briquettes were aged 14 days in air before immersion.

In the above experiments, both cements were commercial cements; but the high-alumina cement when received was not quite so finely ground as the other one, so it was ground to practically the same degree of fineness in a small jar mill (or to 86.2% passing the No. 200 sieve), so that the fineness of the two samples might in no way influence the results. Both these cements were made from cement rock and limestone.

In connection with the use of concrete for mine props, where it is often exposed to the action of dilute solutions of

sulphuric acid, the following experiment was tried. Sand briquettes were allowed to harden 28 days and then were placed in a solution containing 250 grains of sulphuric acid (H_2SO_4) to the gallon. The solution was changed frequently and the briquettes broken at regular intervals. The disintegration of concrete by such acid water is shown by the following:

Age in solution.....	0 days	7 days	28 days	3 mos.	6 mos.	1 year
Tensile strength, lb.	226	299	300	280	176	Disintegrated

Several years ago the question of the action of oil on concrete was brought up at one of the meetings of this Society in connection with a paper by Professor Carpenter. In his experiments, oil was mixed with the concrete. In the discussion which followed the reading of the paper, a number of gentlemen suggested that what was needed most was information relative to the action of oil on concrete which had already hardened, in view of the employment of concrete for machinery bearings, engine room and factory floors, etc., where it is subjected after being fully hardened to the oil which leaks from the bearings of the machinery. I went home from this meeting and had a number of sand briquettes made and allowed them to harden two weeks in air. These were stored in air, in engine oil, in cylinder oil, and in black oil, and broken at stated periods. The results are given in Table VIII.

TABLE VIII. ACTION OF LUBRICATING OILS ON CONCRETE

Age in oil	Tensile Strength, lb. per sq.in., of briquettes kept in Air	Engine oil	Cylinder oil	Black oil
7 days[1]	218	252	235	234
28 days	233	240	273	222
3 months	287	251	221	181
6 months	303	232	209	131
1 year	293	231	203	Broke in clips

[1] The briquettes were aged 14 days in air before immersion.

It will be noted that the engine oil and the cylinder oil have practically no effect upon concrete. One would think that as the latter has a considerable proportion of animal oil in its composition it would be apt to appreciably affect concrete exposed to it. On the other hand, the action of the black oil seems strange in view of the fact that it is a straight mineral product. All of these briquettes had absorbed considerable oil, the actual gain in weight of each set at the end of the year being as follows:

In engine oil	10.6%
In cylinder oil	10.0%
In black oil	12.0%

The briquettes in the black oil had not swollen perceptibly and seemed merely to be weak.

The experiments given above were all made upon very small test pieces and hence the action of the solutions upon them was much more rapid than they would be upon a large mass of concrete; and while in most of the above cases a year was sufficient to completely disintegrate the test pieces, in a large body of concrete such as a pier or wall, many years would be required, at least, to bring about this result. The experiments merely serve to show that even very dilute solutions of the salts of magnesium and the sulphates in general do have a destructive action on concrete and that the generally proposed remedies do not appreciably retard this. They indicate the desirability of employing low-alumina cements in sea-water construction. The experiments with the oils show that no destructive action is likely to take place where cement is used for floors in machine shops and engine rooms.

Rail Failures and Their Causes[1]

By M. H. Wickhorst[2]

Recent years have been active ones in the matter of investigations of rail failures by the railroads, the rail manufacturers and public service bodies, and it is proposed in this paper to consider our present information concerning the nature of the failures and their causes.

From the standpoint of the visible condition of the failed rails most of the rail failures may be divided into three classes, as follows:

1. Crushed and split heads;
2. Broken rails (square and angular breaks);
3. Broken bases (crescent breaks).

In addition to these, there are other failures occurring in smaller numbers, such as "cracked webs" (horizontal longitudinal cracks through the web) and "transverse fissures" (transverse internal cracks in the interior of the head).

[1]Paper before 16th Annual Meeting of the American Socieyt for Testing Materials, Atlantic City, N. J., June 25, 1913.

[2]Enginner of Tests, Rail Committee, American Railway Engineering Association, Chicago, Ill.

Statistics concerning the rail failures occurring in the United States have been published for several years by the American Railway Engineering Association, and in Table I are given a few figures covering rail failures for the year ending Oct. 31, 1911.[3] The tons are long tons of 2240 lb. and represent the tons of new rail laid.

It will be noticed from this table that the failures in 1911 per 10,000 tons of new rail laid were 31.0 for bessemer steel, 20.7 for open-hearth steel, and the average of all rails was 29.0.

On the basis of number of rails, there was one failure per 891 bessemer rails, one failure per 1234 openhearth rails, and one failure per 941 rails of both steels. This suggests that openhearth steel is less liable to failure than bessemer steel, but on the other hand it is probably true that the openhearth rails were in general of more recent manufacture and probably also contain more of the newer sections. The table cannot therefore be said to be conclusive in its indications in this respect.

The table shows us that there was one failure per 941 rails, but we seem not to have general information of all the failures occurring during the full period of service of a

TABLE I. RAIL FAILURES IN 1911

	Bessemer	Openhearth	Total
Tons of rails represented	10,888,706	2,600,008	12,688,714
No. of rails based on 30-ft. lengths	27,866,348	6,622,736	34,489,084
Number of failures:			
Broken	8,165	1,786	9,951
Head	17,761	2,260	20,021
Web	2,450	515	2,965
Base	2,898	806	3,704
Total	31,274	5,367	36,641
Failures per 10,000 tons:			
Broken	8.1	6.9	7.9
Head	17.6	8.7	15.8
Web	2.4	2.0	2.4
Base	2.9	3.1	2.9
Total	31.0	20.7	29.0
Percentage of failures:			
Broken	26	33	27
Head	57	42	55
Web	8	10	8
Base	9	15	10
Total	100	100	100
Number of rails for each failure	891	1234	941

lot of rails. Assuming, for the purpose of forming some idea of the order of magnitude of the average total failures in a lot of rails, that the average life of rails is 8 years, the total failures per lot of rails would average about one failure per 118 rails or something under 1 per cent.

While the American Railway Engineering Association statistics above referred to indicate an improvement in the general failure performance from year to year in the last three years that they have been kept, we still hear of occasional lots rolled in recent years that give very poor service. As an example may be mentioned a lot of 2500 tons of 80-lb. Am. Soc. C. E. bessemer rails rolled in September, 1909, and placed into track in October, 1909. Up to May, 1912, or in a period of service of 2½ years, there were 510 failures classified by the trackmen as follows:

Crushed head and flow of metal	243
Split head	93
Split web	89
Broken	81
Broken base	4
Total	510

This would be 2040 failures per 10,000 tons; or figured on the basis of 30-ft. lengths, there would be one failure in each 13.7 rails in 2½ years from the time the rails were put into service. I am advised that since May, 1912, other rails have been removed from track and still others at this writing (March, 1913) are developing a condition that will necessitate their removal. Thus far about 7% of this lot of rails have been removed from service on account of failures, mostly of the head, and it seems probable that finally the number may amount to 10 per cent. or more. This type of failure, as will be explained, is to be attributed to the interior condition of the ingot from which the rail was rolled, described as segregation and its accompanying conditions.

CRUSHED AND SPLIT HEADS

Head failures are the most numerous and most of these may be described as crushed or split heads. This failure consists of an internal crack in the head running lengthwise of the rail anywhere from a foot or two to several yards in length. The external appearance may show only a crush-

[3]Bulletin No. 147, Am. Ry. Engrg. Assoc., Vol. 14, p. 392 (July, 1912). Also Proceedings, Am. Ry. Engrg. Assoc., Vol. 14, p. 392 (1913).

ing of the head; but when broken, the rail will show a crack in the interior of the head running lengthwise of the rail. A specimen of this type of failure is shown in Fig. 1. This kind of failure is confined almost entirely to metal showing considerable internal segregation of carbon, phosphorus and

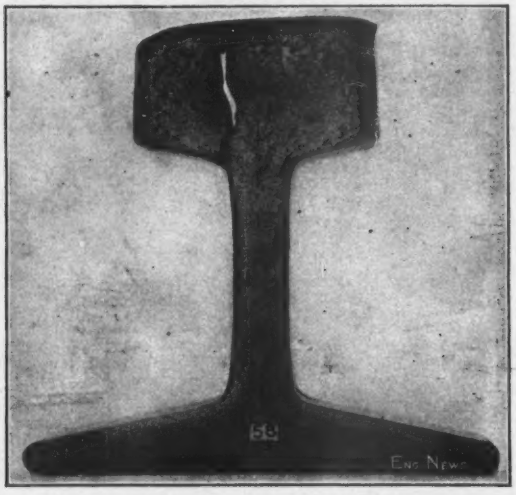


FIG. 1. SAMPLE OF SPLIT-HEAD RAIL

FIG. 2. VIEW OF BASE OF A "BROKEN" RAIL
(Showing seam in base and "Scalloped" break across base.)

FIG. 4. SAMPLE OF RAIL TESTED WITH BASE IN TENSION IN THE DROP TEST
(Showing how a seam in the base was the origin of the failure.)

sulphur, attended more or less with laminations and slag seams.[4] Under wheel loads, the top of the head flows sideways and if the interior metal cannot likewise flow sideways due to internal flaws or due to brittle material in the interior, it develops a crack which grows and later forms a split head, the crack generally coming to the surface at the under side of the head at its junction with the web. Frequently the crack extends downward into the web and comes to the surface at the side of the web, and then the trackman is apt to report the failure as a web failure, whereas in reality it was a head failure.

Split heads may thus be said to be due to lack of transverse ductility in the interior of the head, due mostly to segregation.

[4]See Proceedings, Am. Ry. Engrg. Assoc., Vol. 12, Part 2, pp. 469-493 (1911). See also "Studies of Failed Rails," by W. C. Cushing, Ibid, pp. 230-384.

BROKEN RAILS

The next largest class of rail failures is that called "broken" rails, including square and angular breaks; that is, the rail breaks through the whole section more or less vertically. This type of failure is most predominant in winter, particularly in severely cold weather, and may be termed "winter disease" of rails. The severe winter of 1911 and 1912 brought out a very abundant crop of such failures on the northern roads. An examination of the fractures of such rails shows that the fracture is upward through the section; that is, it starts from the base, and the rails also show longitudinal cracks or seams at the bottom of the base. H. B. MacFarland, Engineer of Tests, Atchison, Topeka and Santa Fé Ry., has made an interesting report[5] in which he shows that most "broken" rails were accompanied by half-moon base fractures, which observation has also resulted from other investigations. Probably the most prominent feature of the appearance of most "broken" rails, is what may be called the "scalloped" fracture across the bottom of the base; that is, the fracture is not straight across the base but one side is concave or re-entrant with a sharp corner, while the other side is pointed and dovetails into it. The concave side of the fracture generally shows also a seam at the bottom of the base. A view of the bottom of a typical "broken" rail is shown in Fig. 2.

SEAMS IN BASE OF RAIL

Rails frequently contain longitudinal surface seams, and in this connection a study of the behavior in the drop test of a rail containing seams in the bottom of the base is important. These base seams vary in depth from a hundredth to a tenth of an inch and occasionally deeper. Fig. 3 gives a view of the vertical fractured surface of a piece of flange broken off from a new rail, showing a deep seam at the bottom of the base.

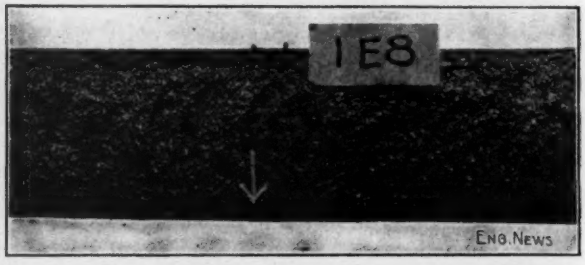


FIG. 3. VERTICAL LONGITUDINAL FRACTURE OF FLANGE
(Showing longitudinal seam in bottom of base of a new rail.)

FIG. 5. SAMPLE OF RAIL TESTED WITH THE HEAD IN TENSION IN THE DROP TEST
(Showing how a seam in the base opened under the tup, causing the base to split.)

When tested in the drop test in the usual manner, the rail ordinarily breaks at or near the place where hit by the tup due to exhaustion of the longitudinal ductility of the part in tension. Occasionally, however, when tested with the base in tension—that is, with the base resting on the supports—the fracture occurs near one of the supports. A view of the base of a rail broken in this manner is shown in Fig. 4. This was a 100-lb. rail broken in the drop test with the base in tension, supports 3 ft. apart, and given one blow of a 2000-lb. tup from a height of 20 ft. The impression left on the base by the support was chalked to show up more clearly in the illustration and it will be noted that the permanent impression was confined mostly to the middle third of the width of the base. It will be noted that the pressure of the rail on the support caused some side spread of the base at this place, which in turn opened up a seam. A piece of the

[5]Bulletin No. 147, Am. Ry. Engrg. Assoc., Vol. 14, p. 315 (July, 1912). Also Proceedings, Am. Ry. Engrg. Assoc., Vol. 14, p. 315 (1913).

flange broke, and a fracture occurred through the whole section 3½ in. from the support, as a secondary break. The failure of this rail occurred long before the longitudinal ductility was exhausted and may be considered as due to insufficient transverse ductility at the bottom of the base because of the presence of seams.

When tested with the head in tension, the result is of a similar nature if there is a seam in the base at the place where struck by the tup. Fig. 5 shows the base of a rail tested in this manner. Here again the blow of the tup caused a side spread of the metal of the base where struck, which in turn opened up a seam causing a failure from the top side, not due to exhaustion of the longitudinal ductility of the head.

BASE FAILURES

About 10% of all rail failures, according to Table I, are base failures, mostly half-moon or crescent-shape pieces broken out of the flange. These occur mostly at ties and appear also to be largely attended with seams in the base. The origin of the failure in this type, as with "broken" rails,

FIG. 6. SAMPLE OF "TRANSVERSE FISSURE" IN HEAD OF RAIL

thus appears to be the seams in the base and these two types should therefore be classed together as regards cause of failure.

OTHER FAILURES

A type of failure that has attracted considerable attention in recent years, is the "transverse fissure" or "oval spot" in the interior of the head, an example of which is shown in Fig. 6. This type was first brought into prominence by a report by J. E. Howard, of the Bureau of Standards, on a rail ascribed as the cause of a bad wreck on the Lehigh Valley Railroad at Manchester, N. Y., on August 25, 1911. C. D. Young, Engineer of Tests of the Pennsylvania Railroad, has also presented an interesting report of his investigations of some failures of this type that occurred on the Pennsylvania R.R.[6] While these reports contain valuable data and good suggestions, the writer feels that a full explanation of the cause of this type of failure has not as yet been worked out, which necessarily must precede effective action for remedying the trouble. This kind of failure is occasionally followed with disastrous results, but fortunately occurs only in small numbers except perhaps under some special conditions.

Another type of failure that constitutes a small percentage of the total failures is the "cracked web," in which the web is cracked through from side to side running lengthwise of the rail; but here again the writer is not aware of a final explanation having been worked out.

SERVICE CONDITIONS AS CAUSES OF FAILURES

Wheel loads have been increasing ever since the beginning of railroads and the tendency seems to be to still further increase them, at any rate as regards the average wheel loads. The heavy wheel loads have been given as the cause of rail failures. While it is true that the loads are heavy, it is also true that failures are confined to what may be called defective rails, and that most rails stand up under the service. The failures classified as crushed and split heads have for some time been recognized as due to defective metal; and although "broken rails" eluded us for a while, as attributable to the material, we may say these also are to be ascribed to defective material although not defective metal.

Bad counterbalance, flat wheels and other abnormal conditions kink good rails and throw them out of line, although of course, the defective rails are more promptly found by such abnormal conditions. A rail tested in the drop test will ordinarily stand a bend of several inches in a span of three feet. Of course the railroad that persists in bending and kinking its rails will soon have an unrideable track for satisfactory service. It seems to be true that such matters as weight of rail or design of section are of but small importance in the matter of rail failures, but are rather matters more concerning the rideablity of track and cost of maintenance.

REMEDIES

The above part of this paper deals with diagnosis and I think we have now arrived at a point where we may feel considerable confidence that we have the correct diagnosis of the causes of most of the rail failures. About 50% are ascribable to low transverse ductility of the interior of the head due to segregation (and its attendant conditions) and traceable to the interior condition of the upper part of the ingot. About 40% are ascribable to low transverse ductility at the bottom of the base, due to the presence of longitudinal seams at the bottom of the base, and probably the origin of these seams is to be looked for in the rolling of the steel. This leaves about 10% not yet diagnosed. What remedies will finally be applied I, of course, cannot say, but below are given some thoughts as to the directions in which betterments are to be looked for.

According to Table I, 55% of the rail failures of 1911 were head failures and 8% were web failures, and as already indicated most of these may be classified as crushed and split heads, attributable to excessive segregation in the interior of the ingot together with the conditions which ordinarily attend such excessive segregation, such as sponginess and an abnormal softness of the steel at the outer part of the rail section around the segregated region of the rail. Thus, it appears that the remedy for about 50% or perhaps 60% of rail failures, is to be looked for in a reduction of segregation below the point where it causes a brittleness of the interior metal of the rail. The condition of sponginess is worst at the top end of the rail bar, but the segregation reaches its worst condition at a varying distance from the top end—ordinarily about 15% of the weight of the ingot from the top end of the ingot—and varies in degree from harmless segregation to a condition sure to result in bad service of the rail. It seems to be well established that well deoxidized, quiet-setting steel has not the concentrated segregation found in other steel and is free from sponginess, but the central pipe extends farther downward into the ingot. The main cause for head failures is, however, the excessive segregation, and to avoid this requires a sufficient discard from the top of the ingot, or steel treated with sufficient silicon, titanium or aluminum. It is usual for rail specifications to put a maximum limit of 0.20% on silicon, but the writer's work indicates it is necessary to have 0.25% or more silicon in the steel in order to obtain its full influence in reducing sponginess and segregation. When titanium is used, 0.1% or more of metallic titanium is probably the proper amount with which to treat the steel. Talbot recommends aluminum[7] used in amounts of 2 oz. per ton or about 0.006%.

It seems that we must come to a well deoxidized dead-quiet-setting steel, but then we have a deep pipe to deal with when the steel is cast in the usual manner into ordinary open-top iron molds. There has been recently, and still is, considerable experimental activity toward overcoming this condition and the next few years may see a practicable and economical solution of this problem of pipe, available on a larger working scale. Hadfield recommends a sand top to the mold and special arrangement to keep the top metal liquid till the bottom of the ingot has set. Talbot recommends a pre-rolling or liquid compression, and a number of other means have come to public attention lately. Possibly, also, some improvement may be obtained by closer attention to the details of the present casting process; or, again, satisfactory uses may be found for the upper part of the ingot for other purposes. The conclusion seems to be emerging, however, that for rails, a well deoxidized, quiet-setting steel

[6] Bulletin No. 151, Am. Ry. Engrg. Assoc., Vol. 14, p. 413 (Nov., 1912). Also Proceedings, Am. Ry. Engrg. Assoc., Vol. 14, p. 413 (1913).

[7] "The Production of Solid Steel Ingots," Am. Inst. Min. Engrs., New York meeting, Feb., 1913.

must be used, in order to avoid excessive segregation and to obtain rails with a uniform hardness at the wearing surface in the several rails of an ingot. A solution of the ingot problem means the prevention of about half of the failed rails of the country.

As indicated above, about 40% of the rail failures are traceable to a longitudinal seam at the bottom of the base. The seam does not show on the new rail and cannot be discovered by inspection, but shows up when the failed rail is examined. We have very little satisfactory information as to the origin of these seams (although they seem to be produced in the rolling), but the matter is being studied more critically and we hope in the course of time to have more satisfactory knowledge of the subject.

CONCLUSION

In conclusion, we may say (considering the number of failures) that about 50% of the rail failure problem consists of obtaining sound metal of fairly even composition, and about 40% consists of so rolling the metal into rails as to avoid seams in the bottom of the base. The earnest activity and the coöperation between all interests to produce improvement in the matter of rail failures, is such that we may well be hopeful of the future. The steel mills have freely offered the facilities of their works to the railroads for experimental work, and I in particular wish to acknowledge the uniformly kindly treatment accorded me in my work at the various mills. As a still further improvement of the general situation, I would urge upon the metallurgists and other officers of the steel mills that they be more forward in publicly presenting the results of their studies and investigations.

Track Elevation and Portable Concreting Plant; C., M. & St. P. Ry.

The Chicago, Milwaukee & St. Paul Ry. is beginning this season to elevate its Bloomingdale Road line at Chicago, which extends along Bloomingdale Road from No. Ashland Ave. to No. Lawndale Ave., a distance of about 2.4 miles. The ordinance for this work (passed June 27, 1910) provides for the keeping open of all cross streets, which will necessitate 35 subways. The estimated cost of the work is about $2,000,000, and it is planned to complete it in about two years.

The line is double track, and the right-of-way is so narrow that no additional tracks will be provided for in the elevation. In fact, it will require a retaining wall on either side for the full length of the elevation to retain the fill for the two tracks. Most of these retaining walls will be about 16 ft. high, and as there are approximately 4.8 miles of such walls to be built, it was desired to secure a modern and efficient method of doing the concrete work.

The foundation conditions are good for the entire distance, and the clay soil will carry safely a load of 2 tons per sq.ft. No piles will be required, and it has been decided to construct the walls of mass concrete. The distance between cross streets or subways is about 275 ft., and the right-of-way is only 32 ft. wide. It is necessary, therefore, to build both retaining walls before doing the filling. On account of the short distance between the cross streets it was deemed impracticable to unload filling material between the retaining walls and gradually raise the tracks to final elevation by jacking, as with this method it would be necessary to block too many streets.

The ordinance provides for a 6-ft. sidewalk on one side of the tracks, then about 32 ft. for right-of-way, next a 22-ft. driveway, and then a 6-ft. sidewalk on the opposite side of the street. This is shown by Fig. 1. In carrying out the work, one of the tracks was shifted onto the 22-ft. driveway space and used for traffic, the line being operated as single-track while the work is in progress. The other track was turned over to the construction forces, and this was shifted to the center of the space between the retaining walls, as shown in Fig. 2.

On account of the extremely narrow right-of-way, it was not possible to cast the material excavated from retaining-wall footings into the fill. Therefore, this material is loaded onto flat cars and hauled out to the new yard at Godfrey, where it is plowed off to furnish filling material. It is intended to build a light, temporary pile trestle for the entire length of the track elevation, and to do the filling from this. After the retaining walls have been constructed for a distance of about two blocks, this trestle will be built and then the excavated material from the retaining-wall footings will be dumped between the walls instead of being hauled away.

The railway company owns a number of steam ditching machines and one of these was secured to do the excavation for the retaining walls. The machine resembles a small steam shovel (with ⅜-yd. bucket) and is mounted on trucks having three gages, one standard and two wider gages. The machine revolves 360° on its frame. In moving, it picks up a section of track from the rear and places this ahead, so that it can advance and continue the excavation. The ties in this track are timbers 8x16 in., 19 ft. long; these are bolted together to form about 6-ft. lengths of track for each section. These long ties span the footing trench, the steam ditcher standing directly over the excavation, and working forward. To operate this machine requires an engineman and fireman; also five or six laborers to attach the chain to the track sections when they are to be moved ahead, and to put down 8x16-in. sills on which rest the ties of the track sections. This machine can excavate from 300 to 450 cu.yd. of material per 10-hr. day, and the method of excavation has proved economical and satisfactory.

For the concrete of the footings of the retaining walls a batch concrete mixer of ½-yd. capacity is used, mounted on a flat car. This dumps over the end of the car into a spout. Hinged brackets on the corners of the car support the spout, so that this may be revolved through 180°. The concrete is deposited by the spout in its final position in the footing, so that there is very little shoveling or casting of the concrete. The material for the concrete is received in gondolas or coal cars. Runways are placed on top of these cars, over which the materials are wheeled directly to the charging hopper of the mixer.

It was decided to build the retaining walls by a plant working on the ground, instead of building the pile trestle first and handling the concrete work from this. The reason for this decision was that men can work more effectively on the ground than when on a trestle 16 ft. high. Therefore, for the construction of the retaining walls (above the footings) a portable equipment was specially designed, operating at the ground level and delivering the concrete in place in the forms by means of an elevator tower and chutes. This equipment consists of a 25-hp. horizontal boiler, a 20-hp. double-cylinder hoisting engine, a batch concrete mixer of ½-yd capacity, and a steel tower with elevator bucket and distributing chutes. The chutes can be revolved through 180° in a horizontal plane, so as to cover both walls, with the machine standing between them on the construction track as shown in Fig. 2.

All this equipment is mounted on a flat car, so as to

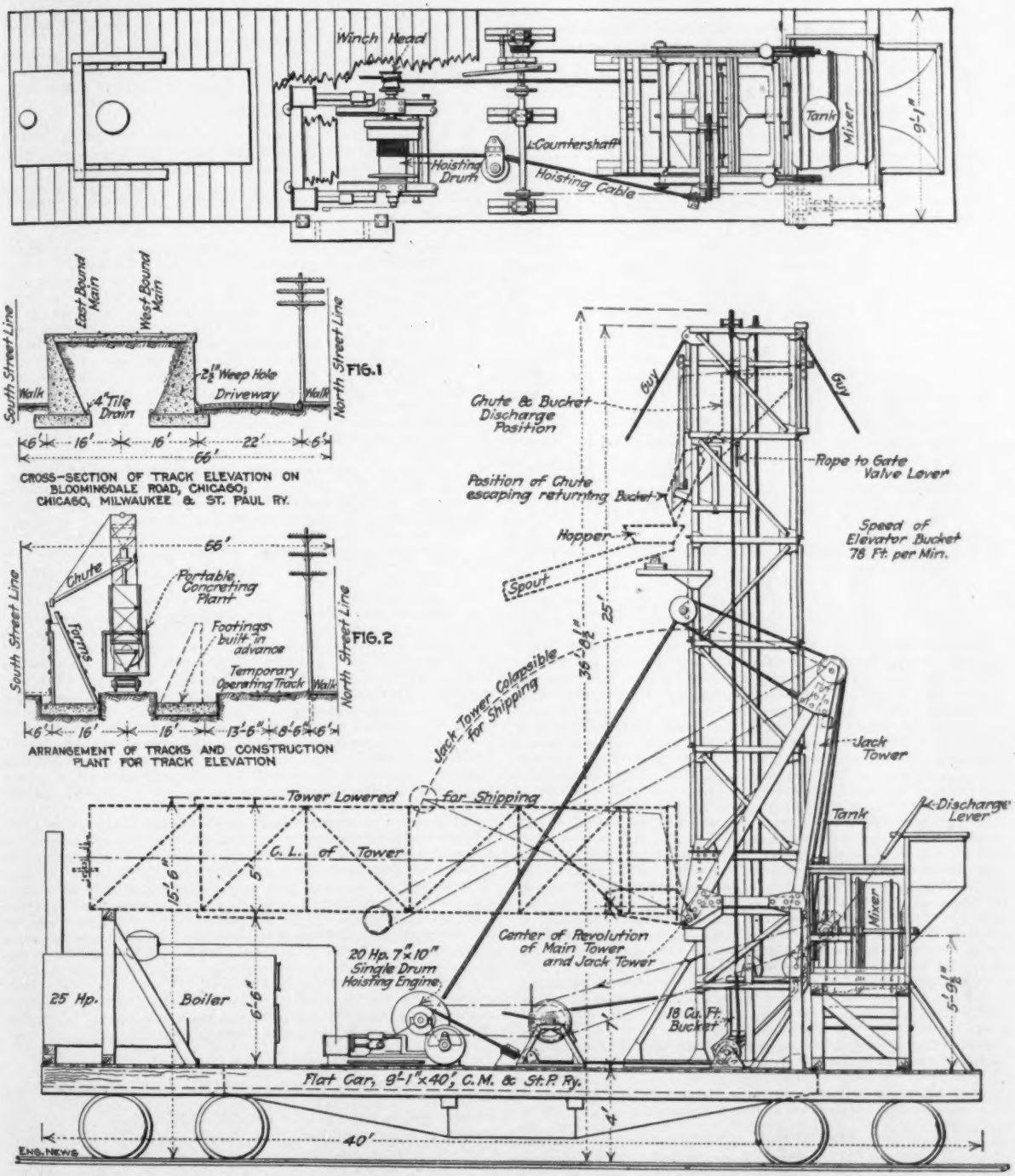


FIG. 3. PORTABLE CONCRETING PLANT WITH FOLDING ELEVATOR TOWER; C., M. & ST. P. RY.
(The Chain Belt Co., Milwaukee, Wis., Builder.)

form a complete and self-contained concreting plant. This is shown in Fig. 3. Practically all the labor cost connected with making the concrete for the walls consists in getting the aggregate to the mixer, which is done in the same way as described above for the portable mixers making the concrete for the footings. The engineman handles both the mixer and the elevator; two other men are required to attend to the water tank and the batch hopper and to discharge the mixer.

A special feature of this concreting plant is that the tower can be lowered or folded, like the leads of a railway pile-driver, so that all parts of the machine come within an overhead clearance of 16 ft., and it can pass under trolley or other wires and under low bridges. The rear legs of the tower are pivoted on pins at about 10 ft. above the floor of the car, and on one of these pins is pivoted also the leg of an auxiliary or jack tower. This is an A-frame of 4x6-in. timbers, carrying sheaves. To

raise the main tower to its vertical position, the jack tower is first raised and secured, and then a line from the hoisting engine is led over the sheaves and back to the tower, which is then raised by the engine. To lower the tower, a snub line is thrown around the winch head of the engine and with a slight pull the tower is pulled back until its center of gravity is behind the center of revolution. It is then lowered by the cable over the jack tower, under the control of a band friction brake. When this is done, the jack tower can be lowered by a line led over the winch head.

The track-elevation work here described is being carried out under the direction of C. F. Loweth, Chief Engineer of the Chicago, Milwaukee & St. Paul Ry., and like most of the bridge and construction work on this railway it is being done by company forces. It is in direct charge of R. J. Middleton, Engineer of Track Elevation, to whom we are indebted for information. The portable concreting plant was designed by Mr. Middleton in conjunction with the representatives of the Chain Belt Co., of Milwaukee, Wis., and was built complete by that company.

The Maintenance of Electric Railway Equipment*

By C. H. Quereau†

Several important steam railroads have replaced (to a limited extent) steam locomotives with electric locomotives and multiple-unit cars. Their successful operation for five or six years and the experience gained during this time makes the subject of the maintenance of electric equipment a live one. The fact that at least six steam railroads are now using electricity for motive-power purposes, and the recent announcements of plans for extensive electrification of main lines on Western steam roads, suggests that almost any steam motive-power organization may be called upon to maintain electric motive-power.

Experience has shown that at least 90% of the problems of maintenance to be solved and the faults to be remedied can be successfully worked out by a good mechanic, with a very limited electrical knowledge, who has had experience in the motive-power department of steam railroads. For the maintenance of electric equipment (whether on trolley, interurban or steam railroad lines), those master mechanics, general foremen and mechanics who have been trained in the motive-power departments of steam railroads have somewhat the advantage.

Some knowledge of electricity for such men is certainly necessary, but is very elementary and simple, preferably practical rather than theoretical. It can be acquired in such a short time that the advantages of using men who are already in the steam motive-power department very decidedly outweigh the disadvantages due to lack of an extended knowledge of electrical apparatus. This conclusion has been reached after six years' experience in an electric equipment maintenance department on a steam railway.

ELECTRICAL TERMS

When the uninitiated hears or reads of volts, amperes, watts and kilowatts, circuit breakers, contactors and other electrical terms, he finds these words meaningless. As a consequence, he gets no adequate conception of the subject discussed and, perhaps naturally, concludes it must be beyond his powers. A little reflection will show him that at one time he was equally ignorant about such commonplace matters as hydrostatic pressure, steam consumption, horsepower, air brakes and superheaters.

The volt is defined as "the practical unit of electromotive force which will cause unit current to be established in a circuit of unit resistance." For all practical purposes it may be considered as the unit for expressing the pressure or tension of an electric current, just as the pound is the unit used in expressing boiler pressure.

There is no doubt arising in the mind of anyone as to the meaning of the sentence, "the boiler carries a pressure of 100 lb." nor is it necessary to be precise and add, "per square inch," because constant use has made us familiar with the meaning of the statement. We know that, other conditions remaining constant, steam at a pressure of 200 lb. will do twice the work of steam at 100 lb. In the same way, a little practice will enable us to understand offhand that there is twice the power in a 200-volt current there is in a 100-volt current, because the former has twice the electric pressure of the latter.

When we become familiar with the fact that the usual voltage of the electricity used about the home for lighting purposes is 110, and that the usual voltage for trolley and interurban (as well as multiple-unit) electric cars, varies from 500 to 600, we have a working basis from which to understand the statement that a transmision line is designed for 11,000 volts. If we read that the Chicago, Milwaukee & Puget Sound Ry. is planning to electrify several hundred miles of its lines, using a voltage of 2400, we understand it is considering the use of an operating current having a voltage or pressure four times that which is usual.

The ampere is defined as "the practical unit of current and represents that value of current which will cause the electrolytic deposition of silver at the rate of 0.001118 grams per second." For everyday use, we may think of the ampere as the unit for measuring the quantity of electricity used or available, just as we speak of pounds of steam or gallons of water. We will know at once that an electric motor using 200 amperes of 600-volt current has twice the power of one using 100 amperes of current at the same voltage, or half the power of a motor using 400 amperes and a voltage of 600.

The watt is the unit of electric power and, for all practical purposes, is the product of the pressure, or voltage, by the quantity or amperes. For instance, the power of a current of 600 volts and 250 amperes is $600 \times 250 = 150{,}000$ watts. The watt in electric power matters is used in the same way as horsepower in connection with steam power. And when one learns that 746 watts are equal to a horsepower, he can, with a little practice, compare the rated power of an electric motor or generator and a steam engine.

A kilowatt is simply a thousand watts and the term is used only for convenience. Mention has been made of an electric current having a power of 150,000 watts. This is usually referred to as a current of 150 kilowatts. A kilowatt is almost exactly equivalent to 1⅓ hp. and a 150-kw. current equals practically 200 hp.

The terms watt-hour and kilowatt-hour are used in connection with electricity just as horsepower-hour is used in steam motive power discussions and means electric power of a watt or kw. used, or available, for an hour.

The ohm is the unit expressing the resistance of a conductor to the flow of electric current and "represents the resistance of a column of pure mercury 106.3 centimeters long, of uniform cross-section and weighing 14.451 grams, at a temperature of zero, Centigrade." It will take but little practice to understand the statement that a conductor having a resistance of 5 ohms will carry twice the current that a circuit having 10 ohms resistance will, or half the current a circuit having 2½ ohms resistance will carry, assuming that the voltage is the same in each case.

MAINTENANCE WORK

It has been stated above that "some knowledge of electricity is certainly necessary, but is very elementary and simple, preferably practical rather than theoretical." It should not be forgotten that this paper relates to maintenance, and is not concerned with the design of electric equipment. Experience has shown that the graduate in an electrical course who is employed in maintaining electric apparatus is apt to require wiring diagrams and blueprints showing the circuits and relations of the apparatus. The inspector whose training has been wholly practical soon learns by precept and practice that a given symptom is caused by a given defect, and does not find it necessary to trace the intermediate steps, but goes at once to the seat of the trouble and removes the cause.

For instance, when an electric locomotive loses power when the motors are operated in series parallel, after having operated satisfactorily in series, the embryo electrical engineer is prone to waste time in hunting up wiring diagrams and tracing circuits. The inspector whose knowledge has been acquired by practical experience knows that either a certain fuse has blown because of an overload, or a certain contactor has failed to operate properly and at once applies the necessary remedy.

*Abstract of a paper read at the annual convention of the American Railway Master Mechanics Association, at Atlantic City, N. J., June 12.

†Superintendent of Electrical Equipment, New York Central & Hudson River R.R., New York, N. Y.

It would be unwise to assume from the foregoing that an elementary knowledge of electricity and the ability to read wiring-diagram blueprints are undesirable to anyone employed in the maintenance of electric equipment. Such knowledge is both desirable and necessary, just as much as for steam equipment, but no more. The point is that the average mechanic, without previous electrical experience, does not require any great amount of electrical knowledge in order to successfully compete with an electrician in maintaining electric motive power.

TYPES OF ELECTRIC LOCOMOTIVES

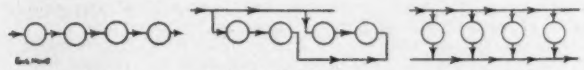
The average nontechnical reader has no doubt been mystified by the terms "series" and "series-parallel." But their meaning is as plain and easy to understand as the terms "simple" and "compound" or "Mallet" applied to steam locomotives.

Most electric locomotives have as many as four motors. When the electric current passes through these motors one after another, as shown in the accompanying cut, the motors are said to operate in series. The circles represent the motors, the lines with arrow points represent the path of the electric current.

When the circuits are arranged so that the current passes through two groups of motors, each group consisting of two motors, they are said to be operating in series-parallel, or series-multiple. That is, two motors are operating in series in each of the two groups, while the two groups of motors are operating in parallel, or multiple; the current supplied to one group of motors flowing parallel to the current supplied to the other group.

If each of the four motors receives its supply of electricity direct, that is, without flowing through any other motor, the motors are said to operate in full parallel, or simply in parallel, the current to and through each motor flowing parallel to that of each of the other motors.

The diagrams will be readily understood if the circles are supposed to represent water motors, and the lines with arrow



Series | Series-Parallel, or Series-Multiple. | Full Parallel, or Multiple.

DIAGRAMS ILLUSTRATING FLOW OF ELECTRIC CURRENT IN RAILWAY MOTOR CONTROL

points are assumed to be a diagram of the water pipes, the arrows indicating the direction of flow.

This brings to mind the fact that the most helpful illustration to an understanding of electric circuits and diagrams is to think of them as showing a water system. In place of the electric motor put a water motor, and consider the wiring plans as showing the distribution and connections of water pipes. The analogy can be carried farther; the water pressure stands for the voltage and the pounds or gallons of water flowing or available, the amperage of electric current; the horsepower-hours of a water turbine are the equivalent of the kilowatt-hours or horsepower hours of an electric motor or generator.

MAINTENANCE OF STEAM AND ELECTRIC LOCOMOTIVES

The statement is occasionally made that an electric locomotive is a simpler machine than a steam locomotive. If this refers to ease of handling and operating or matters requiring the attention of the engine crew, such as injectors, steam pressure and water level, the statement is correct. But in mechanical simplicity or number of adjustable or moving parts that must be inspected and kept in proper relation, the steam locomotive is very much the simpler. There is, however, this fundamental difference favoring the electric machine; that the moving parts of the control are of very light weight, easily accessible for inspection and repairs and not subjected to nearly as great wear as are the corresponding parts of a steam locomotive.

The electric locomotive requires no shopping for a general overhauling, except for a general painting. This is made possible by having a stock of spare parts, permitting the removal of a defective part, the substitution of a repaired part and releasing the engine, the defective apparatus being repaired at leisure. For instance, a set of driving wheels needing tire turning are replaced by an extra set in good condition, this operation requiring not more than five hours with adequate drop-pit facilities. Air compressors, controllers and contactors can be handled in the same way.

The steam locomotive cannot be maintained on this plan, as the boring of cylinders and resetting flues make it necessary to shop the engine, withdrawing it from service for a considerable length of time.

More convincing may be the records made by an electric equipment maintenance department organized by and largely consisting of men whose earlier experience and training were obtained in the motive-power department of steam railroads. There can be no particular mystery or unusual danger in maintaining electric locomotives when the records for the year 1912, after five years service, show a cost of less than 4c. per mile and an average of 48,271 miles per train detention due to electrical apparatus, with a banner record of 249,423 miles without a train detention due to the electrical equipment.

FEAR OF ELECTRICITY

There is quite generally in the minds of the uninitiated a fear of personal injury that prevents them seriously considering the advantages and wider opportunities in the electric-equipment department. This fear is due doubtless in part to the fact that lightning is generally known to be of electrical origin and to the further fact that electricity cannot be seen, as steam and fire can.

A child is not encouraged to play with matches or fire in any form, nor is anyone without experience encouraged to assume responsibility for steam apparatus. The same precautions used in connection with electric matters will assure as small a percentage of injuries and fatal accidents. Life insurance companies charge no higher premiums for men working about electric equipment than for those employed in ordinary repair shops for steam equipment.

The fact is, if simple and inexpensive precautions are taken, there is no greater danger in working about electric than steam equipment. No one with ordinary sense and experience would think of putting his bare hand on the unprotected steam pipe of an injector, even though he cannot see the steam flowing through it. There is no greater danger in connection with electric circuits if the same common sense is used. This statement refers to 600-volt direct current and would possibly have to be modified for materially higher voltages, where the hazard is undoubtedly greater.

⁂

Acetylene for Lighting Block Signals is being tried by the Boston & Maine R.R., at the Reading, Mass., station; and by the Chicago & Great Western R.R., at the Maywood, Ill., station. Acetylene can be used for producing either a steady or a flash light. The latter is economical, being dark for nine-tenths of each second. It is also of value as being distinctive; the flash commanding greater attention than would a steady light of the same intensity. It is claimed by the manufacturers, the Commercial Acteylene Railway Light & Signal Co., 80 Broadway, New York City, that the lamp will operate 24 hr. per day for nine months without attention. At the end of that period the storage tank would require refilling and the lamp should be inspected. A light installed by the Interborough Rapid Transit Co., New York City, on one of its interlocking signals located at the Battery Place elevated railway station has operated perfectly for about a month.

The principle of this lamp is the same as that of the marine type, as used at the Panama Canal (The Marine Lighting Equipment of the Panama Canal, an abstract in the May 22, 1912, issue of the "Engineering News"). It is the invention of Dustaf Dalen, of Sweden, who received the Nobel Prize, in physics, in 1912.

⁂

The Diesel Engine Ship "Hagen," which was illustrated and described in "Engineering News," of May 1, arrived at New York City on June 6. Through the courtesy of the Standard Oil Co. a large party of engineers was taken on board the vessel and an exhibition trip was made down the harbor and out through the Narrows to Sandy Hook and return. The "Hagen" is a tank ship for the oil trade with a registered tonnage of 5460 tons gross, a length of 400 ft. and a breadth of 53 ft. She has an oil-carrying capacity of 7950 tons, and carries 400 tons of oil in her bunkers. Gas oil is used for the engines, the average consumption being about 11½ tons per day. On the trial trip she made 12½ knots with the engines developing 2900 hp. The sustained ocean speed is about 11 knots. The vessel is owned by the German-American Petroleum Co., of Hamburg, Germany, which owns besides the "Hagen," twenty-eight tank steamships with net weight capacities from 4000 to 10,000 tons. It has under construction at the present time eleven additional steamships for the oil trade, of which four are of 10,000 tons capacity and one of 15,000 tons. It has also under construction three additional motor-tank ships, one of which will have a capacity of 14,400 tons. The total tonnage of this company's fleet, including vessels completed and under construction, is 309,600 tons.

The Strength of Steel Cars*

In some of the new all-steel and steel-underframe equipment, the center sill section has been reduced to such an extent that the cars are no stronger than (if as strong as) the wooden cars.

It would seen desirable for the Master Car Builders' Association to set some minimum strength for steel cars which would adequately protect the road handling them, specifying such cross-sectional area of center sill as may be proper. Cars which have less than this cross-sectional area will be considered the same as wood-underframe or composite-underframe cars, so far as combination defects are concerned. The experience with steel and steel underframe cars extends over a period of about 15 years. This experience covers a large number of car types, showing great variations in end-strain resisting qualities.

It has been agreed that the relative values of steel and wood used in car construction for direct tension or compression should be based on the elastic limits of these materials, and that the committee use a ratio of four for the elastic limit of steel to that of oak or yellow pine.

Compared with a wooden car having two center sills, 4x8 in., an equivalent steel car must have an effective center sill area of not less than 16 sq.in. between the points where end strain takes effect. The strains in car underframes due to lading do not add greatly to the stresses from end shocks. As a rule, a loaded car is less liable to damage from end strains than an empty car. For this reason it will not be necessary to introduce load strains, but base the minimum area and end-resisting strength on end strains only.

Modern steel cars have the center line of draft at varying distances below (seldom above) the horizontal neutral axis of the center sills, and draft stops riveted to the center sills. The distance between the neutral axis of any member of the car and the center line of strain acts as a lever arm, through which bending effect is added to direct tension or compression. Strains which do not act in line with the neutral axis of car members will be designated "eccentric strains."

Center sills which are not properly tied together at rear draft stops, located at some distance from bolster, are subject to eccentric strains which have a tendency to deflect them outward or away from the center line of car between draft stops and bolster.

Compression strains acting on car through draft gear or car ends, as the case may be, create strut action in the members of the car framing. Long struts are liable to buckle under compression, for which reason it is customary to set limits for ratio of length to radius of gyration of struts, in order to restrict the excess stress caused by this buckling tendency. The members or parts of members of car framing which require consideration are generally flanges of channels or I-beams, and plates. Their cross-sections are rectangular, or sufficiently close to rectangular to be so considered in order to avoid theoretical computations.

The committee recommends the adoption of a ratio of 70 for length to radius of gyration, which corresponds closely with a ratio of 20 for length to depth "d" of a rectangular section. This depth must be measured in the direction in which buckling may take place. To fulfill the restrictions just given, the length of a member should not be greater than 20 d., or the member must be securely anchored at intervals not exceeding 20 d.

The anchorage of center sills may be accomplished in various ways, the more common methods being by means of cover plates or diagonal braces. The value of such braces increases the value of the center sills. Cover plates add direct value, and diagonal braces add partial value, depending on their angularity.

Braces at right angles to center sills add no value to the center sill area, unless specifically designed as horizontal girders of sufficient strength to transfer all of the end strains from the draft to the side framing, in which case the side framing must perform the functions of center sills, and must be subject to the same rules. The value of braces at point of minimum strength may be added to the center sill area, taking effect in the horizontal plane in which such value lies.

RECOMMENDATIONS FOR STEEL CARS

Existing steed or steel-underframe cars which have less strength than that specified below, should be classified with wooden cars, and subject to the same rules for combination defects: (1) Area of center sills not less than 16 sq.in.; (2) ratio of stress to end strain not more than 0.09; (3) the length of center or draft sill members, or part of member between braces, to be not more than 20 d, where "d" is the depth of the member, measured in the direction in which buckling might take place.

For cars to be built after 1913 a greater strength should be required. Transportation requirements have increased greatly in the past ten years. Heavy freight locomotives (including Mallet road engines), greater efforts to pass cars through yards quickly, and rougher handling of cars, have increased the strains to cars, due to end shock, at least 50%. Manufacturers of couplers, draft gears, draft attachments, etc., are increasing the strength of their specialties, and are generally aiming to obtain double the original strength.

For new cars, therefore the area of center sills should be not less than 24 sq.in. the ratio of stress to end strain not more than 0.06, and the length of center or draft sill members, or part of member between braces, to be as above.

*Abstract of the report of the Committee on Car Construction, presented at the annual meeting of the Master Car Builders Association, at Atlantic City, N. J., June 16-18.

Heat-Treated Steel and Alloy Steel in Locomotive Construction*

Heat-treated carbon steel is being used mainly for piston rods, axles and crankpins. Also to some extent for locomotive frames, main and side rods, springs, wheels and tires. It does not seem to have been tried for boilers or fireboxes.

Alloy steels are being used to some extent in various ways; but mainly for frames, main and parallel rods, piston rods, axles and crankpins. Some roads are using alloy steels for springs, and one is making an investigation of firebox steel.

The use of vanadium is quite extensive in frames. For main rods, piston rods, axles and crankpins, both vanadium and chrome-vanadium, with some nickel, are being used. In springs, some siloco-manganese, vanadium, chrome-vanadium and nickel have been employed. Some use has been made of vanadium and chrome-vanadium in cast iron.

Some roads do and others do not require heat treatment of alloy steels; as a rule it is not required for springs and tires, and no road requires it for boiler steel, cast iron or miscellaneous parts. The average practice as to these special grades of steel is about as follows:

	Heat-Treated Carbon Steel	Alloy Steel
Carbon	0.45 to 0.60	0.30 to 0.40
Manganese	0.45 to 0.70	0.40 to 0.65
Phosphorus, max.	0.05	0.05
Sulphur, max.	0.05	0.05
Silicon	...	0.15 to 0.30
Vanadium, min.	...	0.16
Chrome	...	0.90 to 1.10
Elastic limit, min.	50,000 lb.	80,000 lb.
Ult. strength, min.	85,000 lb.	100,000 lb.
Elongation in 2 in.	22%	20%
Reduction of area	45%	50%

The heat treatment is left largely to the manufacturers. The Pennsylvania R.R. practice for heat-treated carbon steel for piston rods, axles and crankpins is approximate, depending upon the normal carbon of the specifications. It consists in heating between 1500° and 1600° F. and quenching in water and drawing to a temperature of between 1050° and 1150° F., the material not being permitted to get entirely cold between quench and temper. Some roads require axles and crankpins to be drilled for heat treatment. There should be a test piece from at least each quenching charge, but one road requires a test piece from each object treated, regardless of the size of the quenching or annealing charge. The general opinion is that the tensile test is superior to the torsion test.

In general, the use of heat-treated carbon and alloy steels has resulted in satisfactory service, increased mileage having been obtained from the materials with apparently fewer failures. In the majority of the cases the material has not been in service long enough to make a fair comparison.†

Heat-treated carbon steel can be obtained at a slight increase in cost. The cost of alloy steels is approximately double that of the heat-treated carbon steel.

Panama Canal Excavation during May, totaled 2,779,532 cu.yd., a daily average of 106,905 cu.yd. for each of the 26 working days. The rainfall for the month was 1.89 in. The amount of concrete laid in May was 41,482 cu.yd., and 106,119 cu.yd. of fill were placed in dams.

*From a committee report presented at the annual meeting of the American Railway Master Mechanics Association at Atlantic City, N. J., June 11-13.

†The discussion showed that in many cases there has been trouble with heat-treated steel, owing to its inferior quality. —Editor.

EDITORIALS

Subscribers to ENGINEERING NEWS are notified that the index to Vol. 69, just closed, is in an advanced state of preparation and will probably be issued as a supplement to the issue of July 17.

As our readers will recall, we have recently emphasized the enormous amount of engineering work necessary for the task of railway valuation which the Government has undertaken. In a leaflet just issued by H. M. Byllesby & Co., engineers of Chicago, is a view showing a part of the bound volumes constituting an appraisal report made for the Chicago Telephone Co. The view shows four library shelves, some 10 ft. or more long, filled with closely packed quarto volumes. The statement is made that the work of appraisal required an average of 160 men for one year and an average of 60 experts an additional 60 days. If such a vast amount of labor and expense is involved in making an appraisal of the property of a single public utility corporation in a single city, one can form some faint idea of the labor and expense which would be required for appraising the property of all the public utility companies in the United States.

Illustrating the Need of a Code of Ethics for Engineers

A correspondent has forwarded to us a circular letter recently received by his firm from a concern in Brooklyn, N. Y., which, according to its letterhead, is doing business as "Architects and Engineers." The circular letter was sent out by this firm of "Architects and Engineers" soliciting advertisements to be printed on the covers to be used with specifications drawn by the said "Architects and Engineers." We print the substance of the letter as follows *verbatim et literatem*. It will be noted that according to the terms of the offer in the letter, this firm of "Architects and Engineers" "guarantees to specify the goods sold by the advertiser whenever it can do so consistently."

Gentlemen,

As you no doubt know, all Architect's, prepare Specifications, to accompany each set of plans they make. And in the Specifications, they specify and describe the different Materials, Fixtores, Fittings and all Products and just how the different works are to be done. Now when the Specifications are typewritten, they must be enclosed in some kind of a cover to protect them; so we are preparing our 1913-1914 covers for the Printer and we will have Advertisements of reliable Manufacturers whose products we can specify and have used printed on the inside of covers.

We guarantee to SPECIFY and have your WATERPROOFING COMPOUNDS & PAINTS,
used or installed, wherever we can do so consistently on our work, if your advertisement is on our Specification Covers.

Comment on the above letter seems almost superfluous. It may be remarked, however, that such occurrences indicate the real need of the adoption of a definite code of ethics by the engineering profession.

It may be said, of course, that concerns who would participate in so glaring a fraud as that proposed in the above letter would pay no attention to any code of ethics. On the other hand, the adoption by representative engineering societies of a formal code of ethics establishes at once a standard which will be generally recognized by all having to do with professional matters. Any concern transgressing such a code would be seen at once to be guilty of conduct condemned by the profession as a whole. In other words, under present conditions, when every engineer makes his own code of ethics to suit himself, the natural comment of a concern receiving such a letter as that above quoted is to say, "that shows to what lengths some engineers will go." But with a recognized code of ethics in force, anyone receiving such a letter does not have his opinion of the engineering profession lowered any more than he would charge against the medical profession the act of some disreputable M. D. who acts as sponsor for a widely advertised quack remedy.

Short-Term Garbage-Reduction Contracts and Municipal Ownership

Has the time come for municipal ownership and operation of garbage-reduction works? In most of the larger cities of the country which have adopted improved means of garbage disposal, the reduction system rather than incineration is being used; but with the exception of Cleveland and Columbus, Ohio, all the reduction plants are in private hands. The two municipal plants appear to be earning their operating expenses and capital charges (assuming that proper allowance is made for depreciation). The cities which are contracting for garbage reduction are all, or practically all, paying an excessive price because the contracts rarely exceed a term of five years and in some cases, notably in Philadelphia, are for only one year.

Of course, such short contracts mean either high prices to recoup the company before the contract expires or else political control of the city government by the contractor or some go-between. The common practice is to advertise for bids in local papers; and not until the old contract has so nearly expired that there is not sufficient time to build a new plant. This, of course, means little or no real competition.

The reform government of Philadelphia recently met defeat in attempting to secure legislative authority to let garbage-disposal contracts for five years instead of one year. The opposition, of course, was engineered by contractors and politicians who profit by the short-term contracts. An investigation of the possibilities of a municipal reduction plant is now under consideration at Philadelphia. Some months ago St. Louis appropriated $10,000 for an investigation of municipal garbage-disposal methods.

The subject is worth serious consideration by other cities. In some cases incineration will prove to be more promising than reduction, but that can be determined

only by an investigation conducted by competent engineers, in no way committed to either method. It may often happen that a joint reduction and incineration plant will be advisable, the latter to burn readily combustible refuse and supply more or less of the heat required to operate the reduction works.

In any event, it is high time for our cities to stop letting garbage-reduction contracts for short terms. It is questionable whether even a ten-year contract is long enough where so large an investment is involved as is required for building a first-class reduction plant, and of course no other kind should be permitted.

The Los Angeles Aqueduct and Municipal Debt Problem

The virtual completion of the Los Angeles Aqueduct was recorded in our issue of June 19, with appreciative editorial comment on the enterprise of the city and the ability of the engineers responsible for the work. Some problems connected with the early utilization of the surplus waters of the Aqueduct (see ENG. NEWS, Mar. 13, 1913, p. 506, and also editorial note, May 1, 1913, p. 917) remain unsolved—or rather it remains for the people to adopt one of the solutions already offered.

The Aqueduct has cost a round $25,000,000. As usual and proper, in the case of such enterprises, it has a capacity far in excess of future needs. The plan has been to sell this surplus water for irrigation until it is needed for city water-works purposes. Until the surplus waters are utilized in some way, the power plants at the lower end of the Aqueduct cannot be operated up to their capacity.

The voters having turned down the plan to build trunk lines to convey the surplus waters to distant points for sale for irrigation, the logical thing to do seems to be to revert to Chief Engineer Mulholland's plan to sell the water for irrigation within territory which must subsequently become a part of Los Angeles. Under this plan there is a happy equality between the water needs for irrigation and for urban purposes, so when the territory becomes built up and no more water is needed for irrigation, it will all be required for regular city water-works purposes. Besides helping build up the city, this plan has the further advantage of requiring less additional outlay than would the one voted down.

The last point is an important one, because the bonded indebtedness of Los Angeles now requires, for interest and sinking fund charges, 64c. out of a total tax rate of $1.54 per $100 valuation. This makes it desirable to add to the debt of the city the smallest amount possible and also to get as much revenue as possible from the capital already invested in the Aqueduct.

Fickle as the voters sometimes are, it is hardly conceivable that the people of Los Angeles will refuse to vote the money necessary to obtain the largest return in revenue from the aqueduct water and power enterprise, which they have previously indorsed so heartily. Had they been allowed to vote for the Mulholland plan last March, it is probable they would have indorsed it. It also seems probable that the people would be content for the present to have the Aqueduct power distributed by contract with the existing light and power companies, if the latter would make a reasonable short-term agreement. This would aid further to keep down the city indebtedness.

The arguments in favor of municipal power distribution are that the people will be satisfied with nothing short of full municipal ownership of all light and power facilities and that with such full ownership, the profits would reduce the tax rate more than enough to compensate for the additional capital outlay. But there is such a thing as carrying municipal ownership too far, or at least too fast. As to the relative effects of full and partial municipal ownership on the tax rate—that is a point for the engineers and financiers of Los Angeles to settle; and one which should be settled without political bias or prejudice, either for or against municipal ownership.

From whatever viewpoint regarded, the fact that 42% of the Los Angeles tax rate already goes to pay interest and sinking-fund charges should be kept in mind. Equally important is it for the voters of Los Angeles and their chosen legislators to give more heed to their engineering advisers and to lessen their belief in the infallibility of the electorate when it comes to passing upon technical questions. And these principles apply to many another city than Los Angeles.

Concerning Engineering Research—The Useless and the Useful

To many of our readers we doubt not it will seem the climax of absurdity that any intelligent person at the present day should question the value of engineering research. Every ambitious engineering school considers the possession of a research laboratory as the pinnacle of its hopes, or, if it already possesses one, it is ambitious to double its size and undertake work of a larger scope. In some of the government departments having to do with engineering a great amount of research work is going on. A number of the engineering societies have special research committees whose function it is to direct original investigations.

With all this great amount of original investigation going on, it will be considered by anyone, we think, who has a reasonably broad knowledge of conditions, that the influence of this work upon practical engineering is lamentably small. Admittedly, this is in part the fault of the men who are directing active engineering work, whether it be in the manufactory or in the field. These men have, doubtless, too little appreciation of the value of the data obtained in the laboratory. But it is also true that a very large part of this research work is so far removed from practical conditions and is presented to the engineering public in so abstruse and indefinite a way that it is not at all strange the hard-headed practical man considers it of no earthly use.

In order that original investigations shall produce results worthy of their cost, it is, we believe, essential that they be directed to a definite practical end.

It is very much the fashion, we know, to worship scientific investigation as an end in itself. It is common to hear investigators declare that it is unnecessary that any use shall be foreseen for research investigation prior to its undertaking, because all knowledge is bound, somewhere and somehow, to be of use. In support of this idea one hears quoted instances of remarkable results which grew out of the investigations of the first experi-

menters in electricity, or the first workers in the physical or chemical laboratory. It is overlooked that conditions are entirely different today from what they were when the pioneer workers in electricity and chemistry were engaged in their tasks in the early part of the 19th century.

At that time the total amount of scientific knowledge might almost be said to have been within the grasp of a single mind. Today we have at hand the accumulation of a century of experimentation and experience. There are twenty or a hundred special departments of engineering work, in each of which, if one should attempt to accumulate all the published data and information available, the result would be a library of hundreds of volumes. The busy engineer engaged in the practical work of design and construction has not time to keep himself posted on the investigations of a hundred different research laboratories. It is as much as he can do to keep pace with the results of *practical* investigations directed to the development of his own particular field of work.

In saying this, we by no means intend to discount the value of engineering data obtained with such care that they are thoroughly reliable, bearing directly upon the practical problems of the designer and constructor and presented in such shape that their usefulness to the working engineer may be clearly foreseen. If those engaged in engineering research will direct their energies to obtaining data of such a sort, they may perform a great service to the engineering profession.

It is a pertinent question in this connection to inquire what ought to be the relations of engineering research to engineering education. At the present time, it may be frankly admitted, the research laboratory must be considered as a thing grafted on to the engineering school. The engineering undergraduate student has quite enough to do in studying the foundation sciences on which engineering is based, and familiarizing himself with engineering knowledge already accumulated, without attempting to add to the stock of that knowledge by conducting original investigations, even if he were competent to undertake such work, which is not by any means the case.

There is also serious doubt whether it is a good thing to put the post-graduate student into the engineering laboratory and set him at original investigations, with nothing more than a four years' undergraduate course to fit him for the work. Of necessity, such work is either planned and conducted by the professor in charge, with the student who does the work little more than a skilled operator of the machines and apparatus; or, if planned by the student, with his limited knowledge of the practical world, it generally has too little relation to the real problems with which the constructor and designer have to deal to have any useful application.

That this statement is correct is proved by the fact that with all the work post-graduate students have been doing in college research laboratories for the past score of years, very few of their investigations have found practical application in engineering work.

There is, however, we believe, a sort of engineering research in which every engineering student who aspires to reach positions of responsibility in the profession ought to become proficient, in some degree at least. We refer to the research which attacks an original problem in engineering and applies to it an analysis based on well known and established scientific principles and data. It is too much to expect, of course, that an under-graduate student or even a post-graduate student, unless he be an exceptional genius, will become an expert in this work, but it is at least well that the methods to be followed in such work should be obtained during the college course.

There is, perhaps, no field in which the engineering profession needs to develop its abilities more than in this especial sort of work. The great value of the study of physics and chemistry to the under-graduate engineer is that, if it is studied and taught in the proper way, it should lay a foundation for just this ability to make a clear analysis. It is for this reason that the degeneration of the teaching of physics into an exercise in mathematical gymnastics and the degeneration of the teaching of chemistry into an exercise in laboratory manipulation is most to be deprecated. We are not at all certain that the laboratory adjuncts of modern engineering schools have not wrought much injury as well as benefit to engineering education.

The thing that needs to be emphasized to the engineering student is that before he can profitably begin work in either the physical or chemical laboratory to solve an engineering problem, he ought to make a complete analysis of the whole problem and preferably put it in written form. Even the research laboratories in connection with the large manufacturing companies, we strongly suspect, are not free from the error of spending time in operating testing machines and experimenting with laboratory mixtures that might better be spent in doing hard thinking on the problems before them.

We will try to make our meaning more clear by a few examples taken from widely different fields of engineering. Take, for the first example, the design of rail joints for railway tracks. Among the many thousands of inventors who have worked on the design of rail joints are a very considerable number of engineers. Many of the joints which have been developed and offered to the railway public had certain features of excellence, but were impossible of use because the designer, in his study of the problem, had overlooked certain other important features necessary to be provided for in order to make any joint successful in service.

Take, for another example, the history of street-paving development: What a long record of failures and disgrace and financial loss has been recorded in the development of various types of paving because the engineers responsible for them failed to realize the necessity of making ample provision for the enormous forces of expansion and contraction produced by the variation in temperature and moisture.

The engineer knew, of course, as a theoretical matter, that all materials expand under the influence of heat and contract under the influence of cold. He had data at his command giving the coefficients of such expansion and contraction. He had also moduli of elasticity enabling him to compute with considerable accuracy the tensile and compressive strains set up by these actions. Yet it is a matter of comparatively recent date to have thorough and scientific provision made for such movements in street paving, and to restrict the laying of pavements to such seasons as will make temperature stresses in their construction the least.

In the design of dams one can record a similar condition. A study of temperature stresses in the design of dams and provision therefor is a thing of compara-

tively recent date in engineering. Some of our oldest readers may recall the controversy over the relative merits of curved and straight dams waged in the columns of ENGINEERING NEWS a quarter of a century ago, and how little attention, in that famous controversy, was given to the advantage of a curved dam in permitting relief from contraction cracks.

From one point of view, a dam is one of the simplest structures that an engineer designs; but the numerous failures of dams which have occurred during the past twenty years have abundantly demonstrated the fact that, making all due allowance for the number of dams built by incompetent and uneducated men, the engineering profession itself has not given sufficient study to all the conditions affecting the watertightness and the security of dam structures.

The same thing is true in the field of bridge design. It is recognized now that the analysis of direct stresses and proportioning truss members is merely the a b c of the bridge-designer's art, and that at the present day a bridge structure should be designed with due attention to secondary stresses, to forces of impact and inertia, to the effect of corrosion, and to the proportioning of minor details of construction which were at one time considered relatively unimportant.

It is with the comparatively complicated problems with which the mechanical engineer deals, however, that the art of scientific analysis and original research most needs development. The mechanical engineer has constantly put up to him problems of novelty in design. In every branch of mechanical engineering work, changes and progress are constantly demanded. Not a day and hardly an hour passes in the drafting room of any progressive concern but the questions are being asked: "Will this design work?" "Is it an advantage over the other way of doing it?" "What troubles will it obviate that we now experience?" "What new ones will it create?" "How can they be provided for in advance?"

This does not apply to radical innovations only. Changes in dimensions and proportions frequently necessitate restudy of an entire design to obtain the desired results.

It is, of course, true that in the complicated structures with which the mechanical engineer deals, no such rigid mathematical analysis of stresses is possible as obtains in the comparatively simple structures with which the civil engineer deals. The mechanical designer needs good judgment and an eye for proportion as much as mathematics.

It is noteworthy, too, that the conditions of the mechanical engineer's problems are constantly changing. The advent of alloy steel, the reduction in the cost of machining metals, the development of the automatic machine tool have made many things commercially profitable in mechanical engineering that were impossible twenty years ago.

We have said that the mechanical designer cannot subject his work to as rigid a stress analysis as the civil engineer; but if anything he needs to give even more study to his design preparatory to putting it to the proof of actual construction and operation.

It does not follow at all that because a machine works and works successfully its design is good. The annals of engineering are full of records of machines designed by well known engineers and put upon the market by prominent firms, which after a number of years of extensive use were found to have inherent defects which gradually drove them out of use.

On the other hand, it is equally true that a new machine may prove an absolute failure when first tried because of some insignificant error in detail or in proportions, and yet, if it is designed on correct principles, it may ultimately prove of enormous value and importance to the mechanical world.

Many instances of this could be given. A notable one is the Westinghouse air brake for freight-train service, which, when it was given its first public trials in the famous Burlington brake tests, a quarter century ago, developed such terrific shocks in the exhibition trains that it was universally agreed to be impossible of adoption in the railway service.

The experts went home from the brake trials of that year in the full belief that a complicated electric attachment would have to be applied to the air brake to make it operative on long trains. Fortunately, the engineers of the Westinghouse Brake Co. had a clearer perception of the real difficulty with their apparatus. They made a few slight changes in the dimensions of certain passages in their triple-valve, and the brake which had been a monumental failure was converted into one of the most astounding successes in the whole annals of mechanical engineering.

For another example, in a very different field of mechanical engineering, we may take the Mergenthaler linotype machine. For a generation inventors had been struggling with the problem of designing a commercial machine for setting and distributing type. Quite a number of such machines had been actually built, and some of them had been put into commercial use to a limited extent. The Mergenthaler machine attacked the problem in a different and wholly novel manner. It cast its own type, a whole line at a time, as the composition proceeded. Its early work was more or less crude and imperfect, but the sequel proved that it was designed on sound engineering principles, while the competing machines which had vainly struggled to attain commercial success had inherent defects in their principles of operation which could not be overcome.

It will be admitted, of course, that to conduct such research and analysis is one of the most difficult tasks which can be set before a mechanical engineer, but on a smaller scale and in a more elementary way, is is just this class of work which the mechanical engineer must do if he is to properly discharge his responsibilities.

There are, of course, problems which arise in which no technical analysis can determine beforehand whether the solution is possible or impossible. In such problems the thing to do is to resort to the laboratory and subject the new principles of operation to actual trial.

There are other cases, however—and these constitute a great majority of the problems before the mechanical engineer—where he should be able to say in advance, from previous knowledge and data: "This is based on wrong principles and, whether it works or not, will not in the long run prove successful." Or, on the other hand: "This way of accomplishing results has good engineering precedents back of it, and appears to be based on sound and well established scientific principles. If the design and proportions are carefully worked out, there is no reason why it should not be successful."

The New Constitution of the American Water Works Association

Having passed the thousand membership mark at its Minneapolis convention, the American Water Works Association commemorated the event by adopting a new constitution.

The principal changes are the nomination and election of officers by letter ballot and provision for organization of local sections with contributions from the treasury of the Association for the expenses of the local sections up to 25% of the dues.

It seems a pity that the Association did not go further and adopt the method followed by most other progressive technical societies of large and widely scattered membership of selecting the meeting place for the annual convention. Apparently the Association was not yet ready to place this matter unqualifiedly in the hands of its Executive Committee. It is hoped that it will make the change soon. The present electioneering by rival cities during the first two days of the convention and stump oratory from the convention floor when cities are placed in nomination may make "fun for the boys," but it is also a waste of valuable time, especially as most of the nominating speeches are of the spread-eagle city booming type and probably have little effect on the final choice made.

Under the new constitution, the Secretary and Editor is to be chosen by the Executive Committee instead of by popular vote. The change is commendable, but why the choice should be made by the outgoing Executive Committee was not explained.

With its new constitution, its large membership and its final emergence from financial embarrassment, the future of the American Water Works Association looks far brighter than it has for a dozen years past.

LETTERS TO THE EDITOR

The Need of a New Official in Certain Manufacturing Plants

Sir—In watching the development of efficiency methods the writer has been impressed with the fact that one class of manufacturers has apparently not yet fully recognized a method of getting the economic results already being obtained by others.

The head of a well known manufacturing concern remarked a few days ago that "The time has surely come when not only from altruistic motives but for purely commercial reasons as well, we must assume a more humanitarian or if you choose a more Christian attitude toward our employees." In his recent talk before the Electrical Manufacturers' Club, Dr. Eliot said: "Employers and employed alike need to understand better than they do now the conditions under which satisfaction in daily toil becomes not only attainable, but natural and inevitable, and to see clearly that the prime condition is loyalty on both sides."

The attitude of such men is not based merely on benevolence or philanthropy, but on long observation and careful study of labor conditions as affecting productive efficiency. The employer or executive who today takes no heed as to the condition or surroundings of his "hands" outside of working hours or who barely complies with the all too meager laws applying to them while at work, is behind the times, and missing possible direct and indirect profits just as surely as if he neglected modern tools or power generating and transmission methods.

The "big interests," whose yearly payrolls run well up into the millions, are promptly recognizing the situation by the appointment of "welfare managers," "sanitary engineers," "directors of personnel," etc., each with suitable authority and properly organized corps of assistants for his especial field.

The hospitals maintained by some of the big corporations compare favorably with those to be found in our large cities; emergency and retiring rooms are provided in what not many years ago would have generally been considered reckless profusion, elaborate pension systems have beeen inaugurated, and—it pays.

At the other extreme are the "one-man" organizations, of the good old New England type in which "the old man" or perhaps later his son, now dubbed "the boss," knows every man, woman and child in the plant (and very likely the village for that matter) by name; and an accident or unusual absence from work is a cause for personal investigation and, if need be, assistance.

Some years ago it was the writer's privilege to ride with the late Abram S. Hewitt over his mining properties; and the mutual recognition, personal greeting and expression of interest between owner and employees were most refreshing. Unfortunately, such relations are today rare.

But between the "big chaps" and the "little fellows," commercially speaking, say in plants where the payroll runs from $500,000 to $1,000,000 a year, what is being done for the "working comfort" of the employee?

In the majority of cases nothing beyond what is required by the insurance, health and labor inspectors, or what the personal and civic pride of the management may suggest.

To this particular class of manufacturers is suggested the employment of a new official, whom we may term "superintendent of employment and individual efficiency."

The duties of the man may be enumerated as follows:

(1) To hire every person entering the company's employ. This, of course, does not mean that he should exercise his individual judgment, unadvised, but that consulting with the proper department and sub-department heads, he should close final negotiations, and be responsible for results precisely as the purchasing agent is held responsible for his ultimate costs, with regard to need, quality and market conditions.

(2) To keep a record of the age, training, experience, physical condition, etc., of every individual employed. This may sound formidable but it in reality extremely simple and inexpensive, requiring but a single card for each person, which by means of code and symbols may be made to carry data equivalent to several typewritten pages of ordinary description.

Those who have kept such information (and they are surprisingly few) know how valuable it is in emergencies, or when some action is pending upon which personal history or previous environment would have a bearing.

(3) To have general supervision of, and be responsible for, everything pertaining to sanitation, ventilation and relaxation within the plant limits; also of safety devices generally, except that the *maintenance* of all such systems or devices after being properly installed should rest with the mechanical or operating departments.

(4) To systematically but unobtrusively keep track in a general way of the residences, habits, recreations, etc., of the working force, meet them in an "out-of-hours" casual way, and above all get their confidence as the "personal hyphen" between the office and shop elements, and to be if necessary a "go-between" in case of friction between the two. Along these lines the right man might be found (although quietly in the background) organizing a ball team, suggesting and managing a "brass band" or in various ways identifying himself with "the boys."

Obviously, the man for such a position is not to be found at a glance nor had for the asking; but when found, he should earn a substantial salary several times over in (a) obvious and measurable increased efficiency of the working force; (b) a decreased percentage of nonproductive time during payroll hours, and (c) the intangible, but none the less recognizable and definite value of increased loyalty, confidence and contentment of the working force in and out of hours, an important asset not only when labor conditions are uncertain, but in times of financial stress as well, when local distrust and indifference has meant the untimely end of many an industry.

One or two cases by way of illustration:

In a well known Pennsylvania plant the sterilization of drinking water and a few simple changes in methods of ventilation reduced the average "out" hours almost two-thirds the first year, with a noticeable increase in alertness and improved physical conditions throughout office and shops.

A small but well known New England manufacturing company had for years been struggling along in the same old ruts, every department running itself, without much regard for or interference from the "office." A new man took the helm, promptly "fired" some of the worst "sogers" and discontents, and during the first year reduced costs about 15%, increased the business 30% and had the loyalty of every man in the shop. He impressed the force that he was working *with* and not *over* them. Furthermore, he was a man who knew the difference between system and red tape, and as a result doors previously shut were cordially opened when additional banking accommodation was desired.

In a manufacturing town employing both sexes the doctors were doing a land-office business in treating infectious diseases, good help was becoming scarce and the standard was lowering. One manager instituted a system of compulsory insurance, cost and benefits being shared between the company and employee. The expense was small, but *made physical examination imperative.* By hiring none who could not show a clean bill of health and gradually weeding out those already hired, the atmosphere of the plant was entirely changed, others followed suit, and today the entire civic standard of the town is on a different plane.

Referring again to the "man for the job," he should obviously be of middle age, preferably of technical training, and with business as well as engineering experience; not necessarily a teetotaler, but certainly no booze-fighter; a gentleman by birth and breeding, the kind at whom children smile and dogs wag their tails. Such a man in charge of your "bureau of employment and individual efficiency" will be a good investment.

H. C. SPAULDING, Mgr. Technical Dept.,
National Employment Exchange.
30 Church St., New York City, June 11, 1913.

Vertical-Lift Drawbridges without Cables

Sir—The article in ENGINEERING NEWS of June 5, 1913, describing direct-lift drawbridges without cables, states that up to the present time these bridges have been operated by cables and winding drums, the moving span being balanced by counterweights suspended from other cables, and all these cables passing over sheaves on the top of high towers erected on the piers or abutments of the lift span.

This statement is not correct. In the "Handbuch of the Ing. Wissenschaften," for instance, a lift bridge built years ago at Dresden, Germany, is described and shown. For this bridge very similar devices as for the design described in your article of June 5 were applied for the operation as well as for the balancing, without the use of cables, chains or sheaves. On each end of the bridge underneath the floor a pair of counterweighted lifting girders are provided, pivotally mounted on stationary supports and pivotally connected to the span. Toothed sectors engaged by operating struts are connected with the lifting girders for the operation. The bridge span when operated moves vertically for the longitudinal elevation but swings in an arc transversely due to the pivotal movement of the lifting girders [which move in a path at right angles to the center line of the bridge.—ED.] The floor, however, remains horizontal or parallel to itself for any position during the motion.

STROBEL STEEL CONSTRUCTION CO.
Chicago, June 12, 1913.

[Our statement referred to general practice only and reference was made in our article to the existence of a balanced-lever bridge at Dresden. The type of bridge described in our article was one in which the ends moved in a vertical plane. In the bridge at Dresden referred to, the bridge moves in the arc of a circle.—ED.]

Uniform Accounting Systems for the electric-light, heat and power, the gas and the water companies under the jurisdiction of the Board of Public Utility Commissioners of New Jersey became effective on Jan. 1 of the current year. At the same time modifications in the street railway accounting schedules went into effect. The schedule for each utility is available in pamphlet form.

Annual Meeting of the American Society for Testing Materials

The sixteenth Annual Meeting of the American Society for Testing Materials, held at Atlantic City, N. J., June 24-28, 1913, was in many respects the most successful ever held by the society. There were in attendance about 375 registered members, with some 75 ladies, the largest number ever registered, and a new method of preprinting and presenting committee reports and papers quite effectively lubricated the machinery of the sessions.

As is the case with most technical societies, the American Society for Testing Materials has not heretofore had the money nor the energy, the former being the chief lack, to prepare for the annual meeting advance printed copies of the papers which were to be brought before it. In consequence, the sessions were always mainly taken up with the full presentation of reports and papers, which to be properly discussed and understood, had naturally to be read nearly entire, often to the exclusion, from lack of time, of the equally important discussion.

This year, however, the newly organized Committee on Papers, ably led by the Secretary, Prof. Edgar Marburg, and seconded by the secretary's very efficient office organization, instituted a reform, so that of the 22 Committee reports and 38 papers to be brought before the meeting, 19 Committee reports and 33 papers were in type in the hands of the members of the society from two to four weeks before the meeting. In addition rules were prescribed whereby a strict cloture (amenable to extension by chairman or meeting) was imposed on all presentations or discussions. Not only were extra copies of the papers on hand for the members when they registered but the papers for each of the ten sessions were inclosed in a separate large envelope duly labeled for the proper session.

As a result everyone came to the meeting with a definite idea of what was to be presented, the original presentations were brief and to the point and the discussions were distinguished by an absence of that snap judgment which so often mars the proceedings of our technical meetings. While this reform is in great part due to the increasing financial stability of the society, for preprinting is expensive, it is no less due to the energy and wisdom of the committee and officers noted above.

This meeting was the first since March, 1912, which was set back from the regular June date on account of the approaching Congress of the International Association for Testing Materials, held last September. Since the last regular meeting the membership of the society has increased from 1430 to 1574, and the financial condition has measurably improved, this latter being partly due to the increase in proceeds from sale of specifications and other publications of the Society. The Society is now quite prosperous, although, as stated above, the preprinting of papers is a heavy drain upon the bank balance. It was the opinion of the meeting, however, expressed in a vote of thanks to the Committee on Papers, and to the Secretary, that the expenditure is more than justified.

Capt. Robert W. Hunt (Chicago, Ill.), the president of the society, presided for six of the ten sessions and read a presidential address, which is reprinted in part on p. 20 of this issue; Prof. A. N. Talbot (University of Illinois), vice-president, presided at two sessions and A. W. Gibbs (Pennsylvania R.R.), vice-president, at the remaining two. Two recreation periods, Wednesday afternoon and Friday evening, were provided and a smoker was held Thursday evening.

Officers

The following officers were elected for the ensuing year:

President, A. N. Talbot, University of Illinois, Urbana, Ill.

Vice-Pres., Richard Moldenke, Watchung, N. J.

Directors: W. H. Bixby, John Brunner, F. H. Clark and Albert Sauveur. One vice-president, A. W. Gibbs, and four directors, hold over for another years, the term being two years.

A resolution to provide "some more democratic method of nominating officers," presumably by a general primary instead of by a nominating committee, as at present, was referred to the Executive Committee with instructions to report by Feb. 1, 1914.

Committee Reports and Specifications

As an indication of the immense amount of work done by the various Committees during the past year, it may be noted that 22 Committees, some of which contain as many as 16 subcommittees, reported to the meeting. In these reports, 15 specicatfiions were presented for adoption by the meeting and only one was returned to the Committee, leaving 14 new specifications to be sent to letter ballot. Of this number, nine new specifications were the work of Committee A-1 on Steel, one of Committee A-2 on Wrought Iron, two of Committee B-2 on Non-Ferrous Metals and two of Committee D-1 on Preservative Castings. The specification proposed by Committee C-7 on Lime was returned and the Provisional Test proposed by the Committee D-2 on Lubricants was withdrawn by the Committee.

Besides the new specifications, revisions in 19 old specifications were recommended by Committees, 14 of which were by Committee A-1 on Steel, two by Committee A-2 on Wrought Iron and three by Committee B-1 on Copper Wire.

The details of the Committee reports are given below, the Committees presenting specifications being noted first.

Steel

The report of Committee A-1 on "Standard Specifications for Steel," was the most voluminous presented to the meeting. It proposed revisions in 14 specifications and presented nine new specifications. With only minor amendments, all of these were adopted by the meeting to be referred to letter ballot for final consideration. The report was presented by Wm. R. Webster (Philadelphia, Penn.), Chairman, and A. A. Stevenson (Standard Steel Works, Philadelphia, Penn.), and C. D. Young (Pennsylvania R.R.), vice-chairmen.

It was announced that the organization of the Committee for the ensuing year would be headed as follows: C. D. Young, Chairman; J. A. Capp (General Electric Co., Schenectady, N. Y.), and G. Aersten (Midvale Steel Co., Philadelphia), vice-chairman and C. L. Warwick (University of Pennsylvania), secretary. The Committee now has 93 members and 16 subcommittees.

The following revisions in standard specifications were passed to letter ballot for revision, all except those speci-

fications noted below, being of a minor nature or not subject to any comment by the meeting.

Steel Splice Bars.
Structural Steel for Bridges.
Structural Nickel Steel.
Structural Steel for Buildings.
Steel Reinforcing Bars.
Steel Axles.
Steel Tires.
Steel Castings.
Lap-Welded and Seamless Steam Boiler Tubes.
Automobile Carbon and Alloy Steels.
Boiler and Firebox Steel.
Boiler Rivet Steel.
Annealed Steel Forgings.
Steel Shapes, Universal Mill Plates and Bars.

STRUCTURAL STEEL FOR BRIDGES.—Two objections were made to the revision: First, that the outside ultimate unit stress allowed in rivet steel (58,000 lb. per sq.in.) was too high; second, that the prescribed minimum ratio of yield point to ultimate strength (0.5) was too low. The latter was particularly insisted upon, inasmuch as it would allow a yield point of 27,500 lb. per sq.in., an obviously too low value. A variety of motions were made varying from a specific instruction to the Committee to raise the ratio to a motion by Mr. Young, of the Committee, that the clause regarding yield point be deleted from the specifications and the last year's prescription that "the yield point be noted" be left in the specification. This latter motion was strenuously opposed by Prof. Marburg, who argued that at least the 0.5 ratio was an advance over the old absence of any requirement and was as advanced as in any other of the steel specifications of similar nature. The revised specification was finally accepted, with an instruction to the Committee to look into the matter of yield point ratio for report next year.

STEEL REINFORCING BARS—On account of the tests on re-rolled rails reported by Prof. Hatt, and noted elsewhere in this report, the old specification for "Steel Reinforcing Bars" was changed to read "Standard Specifications for Billet-Steel Concrete Reinforcement Bars" and a new specification for re-rolled bars was adopted, as noted below.

STEEL AXLES—An attempt was made to have this revision sent back to the Committee on the ground that it was an incomplete specification, but the motion was voted down and the revision accepted.

STEEL CASTINGS—Objection was made to his revision, particularly in regard to the sulphur and phosphorus content specified, but the objection was not sustained by the meeting, although the question was referred to the Committee for consideration.

NEW SPECIFICATIONS—The following new specifications were presented by the Committee and were all accepted by the meeting to be sent to letter ballot.

Medium Carbon-Steel Splice Bars.
High-Carbon Steel Splice Bars.
Extra-High-Carbon Steel Splice Bars.
Structural Steel for Locos.
Rivet Steel for Ships.
Rail-Steel Concrete Reinforcement Bars.
Cold-Rolled Steel Axles.
Wrought Solid Carbon Steel Wheels for Electric Railway Service.
Blooms, Billets and Slabs for Carbon-Steel Forgings.

The first three of these specifications were objected to by a representative of the American Electric Railway Association on the ground that they did not apply to girder rails but only to T-rails for steam service. He desired some recognition of this either in the form of a renaming of the specification or a revision of them. Mr. Webster stated that the A. E. R. A. was a member of the subcommittee having these specifications in charge, and that they did not bring forward any objections when the specifications were in Committee. It was also stated by a member of the Committee that a number of users were not in sympathy with certain recommendations made by the A. E. R. A. The three specifications were adopted, with the recommendation that the Committee consider the girder rail splice bar for next year.

The representative of the A. E. R. A. also strenuously objected to the specification on wrought solid carbon-steel wheels for electric railway service, on the ground that his Association had held up its specifications on the same subject last year out of deference to the committee of the American Society for Testing Materials, and it would be only right for the latter society to reciprocate this year when the A. E. R. A. is not quite ready to prepare a specification. The Committee replied that the A. E. R. A. had not presented this view to the Committee and that in its opinion the time was now ripe for some specifications. The specification was adopted.

Objection was made to the last specification on blooms, billets and slabs for carbon-steel forgings, because it does not provide any method of discovering hidden piping. One member also demanded more rigid requirements for segregation and a tensile test. The objections were over-ruled and the specifications adopted.

No revision of the specification on rails was presented.

WROUGHT IRON

Committee A-2 on Standard Specifications for Wrought Iron (F. V. Hunnings, American Locomotive Co., Schenectady, N. Y., chairman) reported some minor changes in the Standard Specifications for Engine Bolt Iron and for Refined Wrought Iron Bars and submitted a new Standard Specification for Wrought Iron Plates, all of which were accepted and referred to letter ballot.

The subcommittee on iron reported that attempts to establish figures for vibratory tests on stay-bolt iron had been outlined during the past year, but the tests had not been carried on on account of delays in the completion of the vibratory machine. It is hoped that they will be carried on next year. A new subcommittee having in charge the formulation of a specification for chain iron and iron chain was appointed during the past year, but has not had time as yet to report.

COPPER WIRE

Committee B-1 (J. A. Capp, General Electric Co., chairman) presented some minor revisions in the Standard Specifications for Copper Wire. These revisions consisted mainly in substituting 8.89 for 8.90 (at 20° C.), as the value for specific gravity of copper wire. This was done in the interests of uniformity, to meet the recommendations of the International Electrotechnical Commission. The committee, however, still considered that 8.90 is the proper value, and recommended that this value be adopted at the meeting of the International Electrotechnical Commission three years hence. The committee also substituted resistivity for conductivity throughout the specification. The specifications were accepted to be sent to letter ballot.

PRESERVATIVE COATINGS

Committee D-1 on Preservative Coatings for Structural Materials is now one of the largest and most active com-

mittees in the Society. It consists of 53 members and is divided for the more active carrying on of the work into ten subcommittees. The chairman of the committee during its ten years' existence has been S. S. Voorhees (U. S. Bureau of Standards), but he felt called upon to resign the present year and was succeeded by P. H. Walker (U. S. Bureau of Chemistry). For the first time in its ten years of existence the committee this year presents a recommendation for specifications to the Society, one, a Specification for Law Linseed Oil made from North American seed, and in addition, a "Proposed Standard Definitions of Terms Used in Paint Specifications."

Linseed-Oil Specifications—Tentative specifications for linseed oil were submitted to the Society in 1909. As a result of investigations of oil from all parts of the world made by the subcommittee during the past year, it has decided that the previous tentative specifications can apply only to oils from North American seed. Therefore, subcommittee E (Committee D-1) on Linseed Oil (G. H. Pickard, chairman) recommended that the tentative specifications proposed in 1909 be adapted as standard, with the exception that there be no maximum limit to the iodine number (two of the samples tested had iodine numbers below the minimum set by the tentative specifications). This was adopted as standard by the Society under the title "Standard Specifications for the Purity of Raw Linseed Oil from North American Seed."

Definition of Terms Used in Paint Specifications—Subcommittee F (G. W. Thompson, chairman) submitted additional definitions of certain general terms frequently used in paint specifications as a supplement to the report of a similar nature made to this Society in 1911. This was passed by the meeting to a letter ballot of the Society.

Other Subcommittee Reports—In addition to these two subcommittees, the following subcommittees also submitted reports but no specifications.

Subcommittee B on the inspection of the test panels at the Havre de Grace Bridge reported further on the condition of the panels and truss members which were applied on the bridge in 1906. The condition of these paints is reported upon by a jury of independent examiners year by year.

Subcommittee C on paint vehicles submitted a serise of tests on soya bean and tung oils made by various members, of the committee with a view to working out reliable tests for determining the value and purity of these oils. The same committee submitted, for consideration only, some tentative specifications for turpentine, but it was decided by them not to recommend any specifications for adoption until tests had been made upon samples of turpentine obtained by members of the committee from authoritative and reliable sources.

Subcommittee D presented a report on the Atlantic City steel paint tests similar in nature to the report on the Havre de Grace Bridge test. These Atlantic City tests were placed in 1909 so that the present report gives the result of the fourth annual inspection. The object of these tests is to determine which paint gives the greatest protection from corrosion. As the land on which they have been placed is about to be used for other purposes, the test pieces are soon to be moved to one of the ocean piers at Atlantic City, where they will be observed under more severe conditions for a few more years.

Subcommittee J presented an exhaustive report upon the tests of white paint, which were outlined in the 1911 meeting of the Society. The plans as outlined have all been carried out and the paint panels have been installed near Arlington, Va. The report describes the analysis of the pigment used, the oils used in the paints and the driers, and the various tests made on the paint preliminary to their application to the frame holding the test pieces. Inspection will be made annually.

Non-Ferrous Metals and Alloys

Committee B-2 on Nonferrous Metals and Alloys (William Campbell, Columbia University, chairman) is divided into four sections, as follows:

Subcommittee I on Pure Metals in Ingot Form proposed the revision of the specifications for copper and recommended two proposed specifications: First, for Lake Copper Wire Bars, Cakes, Slabs, Billets, Ingots and Ingot Bars, and, second, for Electrolytic Copper Wire Bars, Cakes, etc. Both specifications were adopted to send to letter ballot. The subcommittee also prepared a short discussion on the "Classification of American Copper."

Subcommittee II on Wrought Metals and Alloys was not able to formulate any specifications for submission.

Subcommittee III on Copper-Casting Alloys had intended to submit some revisions in the manganese-bronze specification, but on account of the present unsatisfactory method of taking test specimens, it could not do so.

Subcommittee IV on White Metals presented a comparative analysis by five members on standard babbitt alloys. The tests were not sufficiently satisfactory, however, and further work must be done before specifications can be submitted.

Cold-Drawn Steel

Committee A-8 on Standard Specifications for Cold-Drawn Steel (C. E. Skinner, Westinghouse Electric & Mfg. Co., chairman) reported that it had carried out extensive tests on materials manufactured for use in automatic screw machines, but that up to this time the committee had not attempted to draft specifications for any material other than that which it would designate as automatic screw stock. It, therefore, submitted "Tentative Specifications for Cold-Drawn Steel; Bessemer Automatic Screw Stock" and "Tentative Specifications for Cold-Drawn Steel; Openhearth Automatic Screw Stock," to be printed in the *Proceedings* but not to be included in the specifications in the *Yearbook*.

Lime

A new specification for lime was presented by Committee D17 (Henry S. Spackman, Philadelphia, Penn., chairman). In presenting the specification the committee noted that few materials have so wide a variety of application as lime. Contrary to common ideas, less than one-half of the product is consumed in the building trade. Most of the lime produced is consumed by the chemical trade, for which use the physical qualities are less important than chemical composition, which may vary through various steps from practically pure calcium oxide to a lime of which the content of magnesium oxide may be about 40%. In the building trade the qualities of greatest importance are the sand-carrying capacity and the strength developed, as well as plasticity, spreading qualities, constancy of volume and strength, etc. These

are largely independent of chemical composition and are affected by the treatment of the lime after it is delivered to the user, as well as in the process of manufacture. It was, therefore, deemed advisable to limit the specifications to requirements directed to securing the proper chemical composition and preparation by the manufacturer, and to omit any physical tests, such as strength of mortar, etc. The committee, however, believed that such tests may be desirable for special purposes and will be engaged in an effort to develop suitable tests to determine constancy of volume, ease of working and cementing value, and intend to continue this work.

The specification was accepted to be printed in the *Proceedings* as a progress report, but was not sent to letter ballot for acceptance as a standard.

Waterproofing Materials

Committee D-8, on Waterproofing Materials (W. A. Aikin, H. S. Spackman & Co., Philadelphia, Penn., chairman), presented as a report a remarkably good digest of the present state of the art of waterproofing concrete, which was especially noteworthy in that it acknowledged, as so many technical societies have failed to acknowledge, the distinction between laboratory tests and actual performance. On account of some objections to its wording which were considered to be too radical, it was referred back to the committee to be corrected in these minor respects, then to be sent to letter ballot.

Reinforced Concrete

Committee C-2, on Reinforced Concrete (F. E. Turneaure, University of Wisconsin, chairman), reported that its work for the year consisted in participation in the well known Joint Committee on Concrete and Reinforced Concrete. This report was first presented to the annual meeting of the American Society of Civil Engineers, Jan. 15, 1913, which was published in Engineering News, Feb. 6, 1913, p. 258. The committee recommended that the report be accepted and that the committee be continued.

Cement

Committee C-1, on Standard Specifications for Cement (George F. Swain, Harvard University, chairman), reported that a Joint Conference on uniform methods of tests and standard specifications for cement had been organized by concurrence of the American Society of Civil Engineers, the Committee on Standard Specifications for Cement of the American Society for Testing Materials, and the Government Departmental Committee on Specifications for Cement. The Conference is now holding meetings with a view toward reaching an agreement which will result in the adoption of a standard specification for cement. The American Society of Civil Engineers and the American Society for Testing Materials are in agreement as to a specification, but the governmental committee is in slight disagreement in regard to a few minor particulars. It is hoped that the complete agreement will soon be reached.

Brick

Committee C-3, on Standard Specifications for Brick, reported progress through its chairman, A. V. Bleininger (U. S. Bureau of Standards). The committee is not ready for a specification as yet but presented suggested methods of testing for building brick, under the subdivisions; (a) vitrified brick; (b) hard burned brick; (c) common brick; firsts; (d) common brick, seconds. Prof. E. Orton, Jr. (Ohio State University), presented, for the committee, some recommended methods for the testing and inspection of paving brick.

The report was accepted to be printed in the *Proceedings.*

Road Materials

Committee D-4, on Standard Tests for Road Materials (Logan W. Page, U. S. Office of Public Roads, chairman), recommended certain definitions of terms used in road and paving work, a continuation of a similar set presented last year. A minority report, signed by Clifford Richardson (New York) and C. N. Forrest (Maurer, N. J.), opposed the definitions of several of the terms, especially the word "bitumen." In reply on the floor the majority stated that they considered the terms defined correctly for American practice and defended their retention. The report, according to the bylaws, must be printed and lie over a year before action can be taken.

Drain Tile

Committee C-6, on Standard Test and Specifications for Drain Tile (Prof. A. Marston, Ames, Iowa, chairman), presented an extensive progress report which outlined the test work now in progress or prospect by the committee and submitted the outlines of some of the specifications upon which the committee is working. The report was accepted and the committee continued.

Other Committees

Committee A-4 (Prof. A. Sauveur, Harvard University, chairman)) on Heat Treatment for Iron and Steel, presented a "Recommended Practice for the Heat Treatment of Case-Hardened Carbon-Steel Objects," that was accepted and passed to letter ballot.

Committee D-2, on Standard Test for Lubricants, had had printed for the approval of the meeting some "Proposed Provisional Tests for Lubricants," but a member of the committee, acting instead of the chairman who was not present, withdrew the report with the proposed specifications for further consideration by the committee.

The following committees reported progress only: D-5, Standard Specifications for Coal, J. A. Holmes (U. S. Bureau of Mines) chairman; D-11, Standard Specifications for Rubber Products, E. B. Tilt (Canadian Pacific Ry.) chairman; C-4, Standard Specifications and Tests for Clay and Cement Sewer Pipes, Rudolph Hering (N. Y.), chairman; A-10, Hardness Tests, D. E. Douty (N. Y.), chairman; E-1, Standard Methods of Testing, G. Lanza (Philadelphia, Penn.), chairman.

PAPERS

In addition to the above committee reports, 38 papers were presented to the meeting. An abstract of the more important ones and of the discussion follows:

Cement and Concrete

The Autoclave Test of Cement—H. J. Force (D., L. & W. R.R.) gave the results of a number of tests of cement which has been subjected to the pressure steam test of the autoclave. Mr. Force described this test in Engineering News, June 21, 1912, p. 1111. The pres-

ent paper contained tables showing the autoclave test results, up to six months only, of tensile strength of cement coming from different mills, together with the chemical and physical composition of some of the different cements.

It was noted that samples of cement which had failed in the autoclave test when retested again after a period of 30 days, two months, six months, or over a year, in most cases passed the autoclave test. In some cases a decrease in tensile strength of the cements passing the autoclave test was shown while others showed an increase, due to the seasoning process, of over 100%. Mr. Force said that this points very clearly to the fact that these particular samples were not properly manufactured, for with certain mills any cement which has not passed the autoclave on the first test had in practically every case passed the test after the cement is held for a period of time. The author stated that it was his belief that the failure of cement to pass the autoclave test is due very largely to the coarser granules (in the raw material) which do not become hydrated when the cement is set up, but the failure of these granules to become hydrated is due to their chemical composition; that is, the granules are composed largely of dicalcium silicate with a smaller proportion of tricalcium silicate. In order to produce a large excess of tricalcium silicate it is necessary that the raw material must be more finely ground and the cement must be burned at a higher temperature. Failure to do these two things, in the author's opinion, is apt to result in a cement which will not pass the autoclave test.

This paper precipitated one of the most vigorous debates of the meeting. At first the discussion was on the purely scientific merits of Mr. Force's test. R. J. Wig (U. S. Bureau of Standards) recited the results of some preliminary investigations made by his Bureau into the autoclave test. After reviewing the history of accelerated tests for soundness and admitting the possibility of the need for a form of such test somewhat more severe than that required by the present standard specifications, Mr. Wig showed diagrammatically the general results of compressive strength tests on concrete cylinders made from cement tested as unsound by the standard tests, as sound by the standard tests only and as sound by the autoclave tests, respectively. These figures, up to nine months, show a slight strength superiority for the autoclave cement but not sufficient, in Mr. Wig's opinion, to guarantee a relation between service and test. He considered that further study must be given the subject before a definite opinion on the value of the autoclave test could be had.

H. S. Spackman (Philadelphia, Penn.) said that the only advantage that might be claimed for the autoclave test is that it insures a more permanent concrete. This it is too early to predict, since no autoclave-tested cement has been in service or under test any length of time. He pointed out, and his figures were afterwards tabulated and shown in curves by L. A. Ferguson (Association of American Portland Cement Manufacturers), that Mr. Force's own paper showed that up to the 6 mos. test (which was the limit of Mr. Force's figures) the mortar briquettes made from cement that failed under the autoclave test had a continuous progressive increase in tensile strength whereas the autoclave-cement mortar briquettes showed an average retrogression between 3 mos. and 6 mos. Mr. Spackman said he was of an open mind regarding the test but would not recommend it.

Prof. R. C. Carpenter (Cornell University) pointed out that the autoclave test might require an increase of cost of cement manufacture and until it is proved to be an effective indication of permanency, specifiers had better go slow in its use.

Allerton S. Cushman (Washington, D. C.) stated that he had made an investigation of the autoclave test at the instance of the Association of American Portland Cement Manufacturers, as the result of which he concluded that the autoclave test would lead to extremely erratic results. He had not been able to find that it procured a cement of any greater strength than the regular tests. He suggested the possibility of some action taking place in the autoclave similar to that in the manufacture of sand-lime brick, an action which would tend to harden the briquette under test so that it would not be a fair indication of what that cement would do under normal conditions of use.

Russell Greenman (N. Y. State Engineer's office, Albany, N. Y.) reported some nine months tests on the autoclave, as a result of which he is not convinced of the worth of the test as an indication of service.

P. H. Bates (U. S. Bureau of Standards) said that tests he had made showed that the same hydration is not produced in the autoclave as out of it, so that it is apt to be an unsafe method of predicting outside conditions. He also stated that in view of the present unsettled state of cement chemistry it was at least dangerous to attempt the generalization regarding the dicalcic and tricalcic silicates that Mr. Force's paper makes.

This ended the scientific discussion of the paper, though the presiding officer (Prof. Talbot) asked if there was not some one who would defend the use of the test.* Between Mr. Greenman's and Mr. Bates' remarks Prof. Marburg (as a member of the Society and not as Secretary) remarked that he considered that any one devising a drastic test on some material for which standard specifications required another and less severe test should thoroughly establish the reliability of that test before advocating its use. He thought it undesirable that manufacturers and consumers both should be obligated to prove to their individual satisfaction the reliability of a test before it had been submitted to a qualified body, and that opinion as to its merits should be held in obeyance until investigation could be officially made.

After Mr. Bates' discussion, Robert W. Lesley (American Cement Co., Philadelphia) presented a resolution calling attention to the work of the past on soundness tests and moving (1) that Mr. Force's paper be referred to Committee C-1 on Cement for investigation and report upon the autoclave test and (2) that it be the sense of the meeting that this and similar papers reflecting upon tests prescribed by standard specifications be not presented to the Society without having been submitted first to the committee in charge of the subject concerned. The wording of the second half of this resolution, and Mr. Lesley's remarks in support of it stirred several of the members to instant objection. It was pointed out that, *on the face of it*, Mr. Force's paper did not suggest any changes in the present specifications and that therefore the second part of the resolution, coupled

*A letter in favor of the test from the Allentown Portland Cement Co. was later read by Mr. Force.

plied for commercial and domestic services. The fact to the first, was clearly out of order, and that furthermore it was obviously unfair to attempt to throttle members who wished to criticize a specification by allowing the very men who prepared that specification to have the power of suppressing the criticism. By the rules of the Society the Committee on Papers has full power of acceptance or rejection and these powers should not be superseded.

Mr. Lesley finally withdrew the second half of his resolution and the first part (that the subject be referred to the Cement Committee) was adopted by the meeting.

A NEW METHOD OF DETERMINING THE CONSISTENCY OF CEMENT—A new method of determining the consistency of cements, mortars, concrete, clays or any plastic substance was described by the inventor, Cloyd M. Chapman (Westinghouse, Church, Kerr & Co., N. Y.). This method consists in depositing the mortar or concrete in a small metallic cylindrical mold split vertically along an element and noting the amount of opening caused by the sluffing down of the mixture when the cylinder is dropped a certain distance. This test is not advanced as a substitute for the Vicat or ball test but as a general consistency test for all plastic materials. It is now in process of standardization in certain laboratories and some of the committees of the society will take up its study next year.

THE HYDRATION OF CEMENT—Henry S. Spackman (Philadelphia, Penn.), described, in a paper entitled "Estimation of Fine Particles in Cement by Rate of Hydration," some experiments that he had undertaken in an effort to discover if there was any relation between the rate of hydration of cement and the proportion of fine particles in the cement. The author stated that the tests were in no way conclusive and were open to criticism for lack of completeness and crudeness of methods employed, but that they were sufficiently concordant to suggest, if not to prove, the existence of a more or less definite relation between the fineness of grinding on the one hand and the decrease in specific gravity and increase in the content of water of combination of the hydrated cement on the other hand.

P. H. Bates (U. S. Bureau of Standards), in discussing Mr. Spackman's paper and also Mr. Beals' paper, noted just below, stated that it was extremely unsafe to attempt to theorize on the behavior of cement until there was a much more complete knowledge of just what cement is and how is hydrates.

Louis N. Beals Jr. (St. Louis, Mo.), presented the results of some tests on observations of the heat evolved by cement in the setting period, as a result of which, on account of analogous behavior, he concluded "that the time of set and tensile strength are due to the colloidal nature of the cement."

ACTION OF CERTAIN SUBSTANCES ON CONCRETE—A paper under the above title was read by Richard K. Meade (Baltimore, Md.), and is reprinted on p. 21 of this issue. Other investigators prevent confirming in the main Mr. Meade's results. R. J. Wig (U. S. Bureau of Standards), reported that the Bureau has now under study a great number of concrete structures and pieces in all parts of the arid West, where alkali trouble has been experienced. It is hoped that some useful results of the study may soon be reported.

[*To be continued in issue of July* 10]

American Water Works Association

The thirty-third annual convention of the American Water-Works Association was held at Minneapolis, Minn., June 23 to 27. Between 600 and 700 persons were registered, of whom about 260 were active members and about 120 associate members. A large number of papers and committee reports were presented, the latter being chiefly progress reports. A new constitution was adopted and also specifications for valve and hydrants. A joint session was held with the Society for the Promotion of Engineering Education at which Edward Wegman gave a lantern-slide talk on Masonry Dams and Profs. D. W. Mead and O. L. Waller opened an interesting discussion on Hydraulic Engineering Education. Aside from this topic the subject which brought out the most extensive and b yall odds the most spirited discussion was private fire protection, with special regard to charges or free service and dangers to the public health and to the integrity of the water-works system generally arising through interconnections between the public and private (polluted) water-supplies.

Two features of the convention in the way of instruction and entertainment, respectively, were a visit to the Minneapolis water-filtration plant and an excursion to a park, followed by a theater party. The entertainment features named, and others as well, were provided by the Water-Works Manufacturers' Association, the members of which had numerous and extensive exhibits which should properly be classed among the instruction features of the convention.

PRESIDENTIAL ADDRESS

The address of President Dow R. Gwinn reviewed some of the possibilities for the Association and its members and also dealt with some of the practical water-works problems of the day. Taking in the Central States, Illinois, Indiana, Southwestern and Tri States associations as sections of the American Water-Works Association was mentioned as an early possibility.

Mr. Gwinn recommended that members keep records of typhoid cases and deaths in their cities and also record facts showing the relation or nonrelation of the typhoid cases to the local water-supply. He also recommended that fire losses per capita be ascertained and recorded and that greater pains be taken to record water output accurately and that better distribution-system records be kept. Approval was expressed of the extension of public utility commission regulation and of uniform accounting; also of the present tendency to provide more fire hydrants per mile of mains.

PAPERS AND DISCUSSIONS

RATES AND RATE MAKING—A clear and logical exposition of the facts involved and methods employed by the Wisconsin Utilities Commission in determining equitable water rates was presented by Halford Erickson, member of the Commission. The basic principles are cost of service, including depreciation, and a reasonable reutrn on capital investment. This necessitates a physical valuation of the works. In determining this, both cost new and reproduction cost are of service. Demand or ready-to-serve as well as actual service costs must be taken into account, both as regards fire protection and water sup-

that fire protection is often the most important element in demand cost is generally overlooked, particularly in municipal works. Flat rates are inevitably discriminatory. Meter rates are much better. The cost of fire service should be placed on the city as a whole. When fire-protection charges are based on the number of hydrants or the mileage of mains it restricts extensions for domestic and other general purposes.

The somewhat extensive discussion of Mr. Erickson's paper was mostly in the line of hearty approval. John W. Alvord said the author had stated the fundamentals of rate making, which do not rest on the opinion of any one person but on the consensus of opinion through a long period. Prof. D. W. Mead said that rates are a matter of fact and of equity. Leonard Metcalf said that in view of recent rulings, some feel that a sufficient return on capital investment is not being allowed and that capital will be driven into other channels. Allen Hozen urged that there is more danger in low rates than in high. As a rule, works with high rates give good service while works with low rates cannot afford to do so. John M. Diven remarked that second-class cities in New York State are compelled by statute to make the same fire-protection charges against all buildings.

PRIVATE FIRE SERVICES—Three papers on this general subject, with discussion, occupied all of one long session and part of another. W. E. Miller, of the engineering staff of the Wisconsin Utilities Commission, gave his personal views of charges for private fire service, based on conditions at Milwaukee, Wis. Predicted on private services being metered and the cost of the whole fire-protection system of Milwaukee being a public charge instead of a burden on the general consumers, Mr. Miller has reached the conclusion that "The Milwaukee waterworks should continue to furnish service to private fire systems free of special charge." In general, Mr. Miller believes this rule should be extended to other works, but as conditions at some places make this impracticable he was not prepared to say that the rule should be of universal application.

A notable study of the whole subject of private fire-protection charges, accompanied by a digest of answers received from questions sent to many water-works, was presented by Leonard Metcalf. There appears to be no standard practice as regards charges for private services in the United States. In the majority of cases 4-in. pipe for private fire connections should be the maximum limit, particularly in built-up sections. Private fire services should be independent of other services. Some system of protection against stealing and leaks from fire services should be provided. Charging for this service is a matter of local expediency. There are strong arguments on both sides.

Robert J. Thomas, of Lowell, Mass., presented some new facts regarding a typhoid outbreak which occurred in his city in 1903, due to interconnection between the city water service and a private fire service, supplied with polluted water. There was a check valve between the two services and a stop gate back of the check valve. The latter was supposed to be opened by the water department only, but during a fire it was opened by an employee of the owner of the fire-protection service and was left open for many hours. Meanwhile water very heavily charged with sewage went into the city mains. This was followed by 168 cases of typhoid fever and nine deaths, far above the normal. The city has since established a rule under which city water will not be served on any premises having a secondary or supplementary service, unless the latter is also supplied by the city, all fire services are metered.

In the lengthy discussion that followed these three papers there was a general agreement that fire connections larger than 4 in. should not be permitted (though several of this size might be ordered where necessary); that water passing through such services should be metered and paid for (except that used to extinguish fires); and that no connection should be allowed between city and private fire-protection mains, especially when the latter are supplied with other than city water. Some went so far as to oppose supplying city water where private supplies are maintained, whether (knowingly) interconnected or not. Much suspicion was cast on the safety of even duplicate check valves. The detector meter was approved by some, but several thought it too costly for general use. One of the chief dangers from check valves, several agreed, arises from corrosion, which is as liable to affect two valves as one. Mr. Metcalf spoke several times against too sweeping generalizations. He favored looking upon each case as a matter of expediency, in view of governing local conditions It having been urged that while municipally-owned plants might without trouble meet the cost of private fire protection by general taxation, private companies are without this resource. Mr. Gwinn read decisions of the supreme courts of Tennessee, South Carolina and Massachusetts to the effect that the cost of this service is a special benefit, not necessarily paid for through taxation only.

REFORESTATION OF WATERSHEDS—Experience at Hartford, Conn., was outlined by Ermon M. Peck. Some 200 acres have been reforested. The city maintains its own nursery. The small trees are planted 6 ft. c. to c. in furrows 5 ft. c. to c. White pine has been a favorite for planting because of its rapid growth and its value for lumber, but within the past three or four years it has been attacked by a disease, probably the cottony scale. It remains to be seen whether this will prove to be more than a temporary setback. John M. Diven stated that the city of Troy, N. Y., planted 200 acres last year, 1200 trees per acre, at an average cost of $11.14 per acre. Three rows of Norway spruce have been planted around 6½ miles of reservoir shore line to exclude leaves.

THE BASIC PRINCIPLES OF GROUND WATER COLLECTION, with illustrations from experience at South Bend, Ind., and Des Moines, Iowa, were presented in a paper by Charles B. Burdick. A. A. Reimer (East Orange, N. J.) cited a decision of the highest court of New Jersey which reversed previously accepted law in that state and held that ground water is subject to the same miles of ownership and diversion as that flowing in surface streams—only the facts of diversion must be proved. Since the decision the city has been conducting hydrographic studies to get the facts as to its own ground water source. A speaker from Memphis stated that in two cases groups of wells added to the large system there have not increased the total yield as indicated when pumping from the new wells alone. On account of this interference they are now working on a plan of segregation, involving an extension of the well system to a length of ten miles or so.

THE USE OF LIQUID CHLORINE FOR STERILIZING

WATER—This relatively new phase of chlorination was presented by John A. Kienle, sanitary engineer for the Electro Bleaching Gas Co. The history of the process was outlined and the results attained at Wilmington, Del., and several other places (ENGINEERING NEWS, May 29, 1913) were presented in detail. D. D. Jackson outlined his own studies of liquid chlorine in connection with a 40,000,000-gal. reservoir of the water-supply of Brooklyn, N. Y. The feed there is by weight instead of by volume, with balance beams and a friction wheel. The latter works on one side against the flow or volume of water and on the other against the flow of chlorine. Another speaker cited the rise of liquid chlorine to reduce the increase of bacteria which commonly follows copper sulphate treatment to reduce troublesome organic growths. The full desired reduction was not secured but further tests are to be made.

WATER FILTRATION—Considerable parts of three sessions were given up to water filtration plants and problems. The Toronto slow sand and the Minneapolis mechanical plants were described at length by F. F. Longley and W. N. Jones, respectively, in each case with the aid of numerous lantern slides. At the Toronto plant the use of oxyhydrogen flame for cutting into a 72-in steel main resulted in such troublesome fumes from the burning of the pipe casting as to make cleaning away the coating imperative. At Minneapolis the spring water dealers, when their 5c. per gal. spring water had to compete with 8c. per 1000 gal. filtered water, resorted to all sorts of stories to keep up their business. One story alleged that since beginning to treat the water with alum there had been a great increase in skin diseases. The Minneapolis plant, it may be added, is noticeable as having been built by the city, under force account.

A mechanical filtration and softening plant at Fargo, N. D., was also described and illustrated by F. L. Anders. Besides softening the plant is designed to remove odor, color and bacteria. The plant has various uptodate features, including a laboratory.

The use of alum in connection with the slow sand filters at Washington, D. C., was described by Wm. F. Wells. After a five-years' struggle with a heavy turbidity load at times of high water, popular prejudice against the use of alum was overcome and the early recommendations of the consulting engineers to use alum at times was adopted. The use of alum before filtration introduces a needed flexibility into the system, cuts down the peak load, increases the possible rate of filtration and reduces the cost of operation. The treatment as a whole now gives a perfectly clear supply with less than 10 bacteria per c.c., so hypochlorite is not needed. Several speakers interrupted the paper as evidence that mechanical filters should have been installed instead of slow sand filters, but it was pointed out that this conclusion did not necessarily follow as the so called modified slow sand system was recommended at the outset. D. D. Jackson remarked that prejudice against chemical treatment is being overcome and that mechanical filtration is the coming thing. Several speakers stated that prejudice against alum still has to be met, although it is much less than than formerly.

A long paper on "Modern Filter Practice," by Nicholas S. Hill, Jr., reviewed the subject and gave many statistical data regarding existing filter plants. The tendency with slow sand filtration is for an increasing period of sedimentation and an increasing rate of filtration. Mechanical filters are increasing in size of unit and in rate of application of wash water. Disinfection, particularly with chlorine, has a marked bearing on filter plants, reducing their size and cost. Water disinfection has come to stay.

"What Is Pure and Wholesome Water" was discussed in a paper of 35 printed pages by Geo. A. Johnson and in a half dozen written discussions by Rudolph Hering, C. E. A. Winslow, Geo. W. Fuller and others. A rational basis for judging the purity of water and a simplification of water analyses were urged by Mr. Fuller and indorsed by those whose discussions were read. Mr. Fuller stated that he now tries to get the color of water down to 10 parts per million. Mr. Hering urged discrimination between real and imaginary dangers from water. The bacterial standard for certified milk is 10,000 per c.c. [and some cities have standards of from 100,000 to 1,000,000 for ordinary market milk] yet exceptions have been taken to a few bacteria in water.

GELATIN AND AGAR BACTERIAL COUNTS FOR CONTROLLING FILTER OPERATION—James M. Caird read a paper on this subject. In it were embodied the results of gelatin counts at 20° C. for 48 hours, agar counts at 20° for 48 hours and also agar counts at 37° C. for 24 hours, the latter being the new standard recently recommended by a committee of the American Public Health Association. The figures showed a higher average percentage of bacterial reduction at filter plants using the new standard than at those using the old. The conclusion of the author was in favor of continuing to use the old 48-hour incubation period at 20° C. on gelatin together with presumptic tests for B. coli, "from which fairly accurate results can be secured in 24 hours."

Prof. Edward Bartow briefly summarized parallel tests by the two methods made on 1500 samples by the Illinois Water Survey. The samples were classified into four main groups and the average of the ratio between total counts on agar at 37° (as 1) and gelatin at 20° were given. Untreated surface waters from the Mississippi River stoo das 1 to 2.1; from smaller rivers, 1 to 2; from Lake Michigan, 1 to 45. Treated surface waters stood 1 to 5. Water from shallow wells, 1 to 25. Prof. Bartow was in doubt as to which was the best method; both together would be preferable. Some who discussed the paper argued strongly for the old or gelatin count but perhaps more even in favor of using both. Finally, D. D. Jackson moved that the sense of the meeting was that both standards be used. The motion was carried.

WATER MOVEMENT, AIR MOVEMENT AND LAKE CONTAMINATION—A notable contribution on the study of water pollution in relation to surface currents caused by wind movements was made by J. Walter Ackerman, of Auburn, N. Y. An outbreak of typhoid fever in Auburn having been attributed by specialists to infection of a stream by a high school located on an inlet four miles above the head of the lake and 14 miles from the water intake a suit was brought against the school trustees for violation of the penal code in maintaining a nuisance against decency and health. Air velocities and lake curren velocities, and the direction of both wind and water currents were observed, the latter by the aid of floats located every three minutes by triangulation. The conclusion was that the infection of the stream passed to the water intake in two days or so, quite within the life of

typhoid bacteria in water. The outbreak, it may be added, took place when the water temperature was low. Written discussions were read from Profs. C. E. A. Winslow, W. P. Mason and Geo. C. Whipple, all of whom took part in the investigations or litigation and bore witness to the unique and valuable character of the studies made by Mr. Ackerman. It was agreed that the incident tended to show necessary modifications in accepted theories regarding lake pollution, but Prof. Whipple in particular called attention to the likelihood that the conditions here prevailing might not be duplicated except under similar conditions. John M. Diven stated that in view of this incident the city of Troy, N. Y., had engaged Prof. Mason to study the possible like infection of a small lake forming a part of its water-supply. Prof. Whipple's communication stated that several studies of lake-water movement are now being carried out under his direction.

POWER FROM CITY REFUSE FOR PUMPING—The advantages of garbage inceneration and the possible utilization of the resulting heat for power were outlined in a paper by E. H. Foster, of the Power Specialty Co. In this country destructor steam is user for the direct driving of pumps at Montgomery, Ala., Westmount, Que., and Savannah, Ga., and steam-electric power at Milwaukee, Wis., and Savannah, Ga.

HISTORICAL AND DESCRIPTIVE PAPERS—The water-supply of Manila, P. I., was described by H. A. Keeler. A 24,000,000-gal. gravity supply is derived from the Monquina River, on which a 220,000,000-gal. reservoir has been formed by building a stone and concrete dam 85 ft. high. A supply main consisting of 10½ miles of 42-in. riveted-steel pipe, coated with hot mineral asphalt, and of 4½ miles of concrete lined conduit leads from the impounding reservoir to 18,000,000- and 54,000,000-gal. receiving reservoirs near the city. All water is sold by meters, at 9c. per 1000 gal. for the first 4000 gal. per month and 8c. for all in excess of that amount. The natives and other poor people get water free by buckets filled at 230 street hydrants.

A description of the water-supply of Mobile, Ala., mostly historical, was sent in by Edgar B. Kay. The consumption is now over 204 gal. per capita. The centrifugal pumping plant of Minneapolis, which supplies the filters, was described in some detail.

Papers read by title and passed to printing with little or no discussion included "Water Works Special Franchises," by Henry de Forest Baldwin; "Results of Water Waste Work in New York City," by I. M. de Varona; and "Support and Aid to Health Officers," by H. F. Dunham.

COMMITTEE AND OTHER REPORTS

The Executive Committee reported that it had voted to decline an invitation from the American Institute of Electrical Engineers to appoint a committee on electrolysis with power to coöperate with like committees from other societies. The reason for the declination was (1) that the Association had taken a stand on electrolysis 13 years ago and saw no reason to change it; and (2) that there seemed to be little likelihood of agreement with committees from the electrical societies.

The Finance Committee reported a substantial surplus of $1338 at the close of the fiscal year, and all outstanding bills paid. The secretary reported a total membership of 1001, including over a hundred members elected at the opening session.

The Committee on Revision of the Constitution (Dabney H. Maury, chairman) submitted a draft of a new constitution which, with slight amendments by the Executive Committee and from the floor, was adopted and went into effect at once. The principal changes in the constitution are in the method of electing officers; the reduction of the vice-presidents to one; the authorization of geographical and technical sections, the expenses of the former to be met in part from the funds of the Association; the separation of the office of secretary and treasurer and the creation of the office of editor, which may be merged with that of secretary. Hereafter both nominations and election of officers will be by letter ballot, the leading candidates for each office on the nominating ticket going on the ticket for final election. Of the two candidates for president the one having the most votes at the final election will be president and the other one will be vice-president. The secretary and editor will be appointed annually by the outgoing executive committee, which will consist of the president, vice-president, treasurer, secretary, editor, chairman of the finance committee and six trustees, two of the latter to be selected each year.

The Committee on Standard Specifications for Hydrants and Valves (B. C. Little, chairman) submitted specifications which, after considerable discussion, were adopted without change. These specifications were printed in pamphlet form. The committee was continued, with instructions to submit recommendations for further changes in the specifications if needed.

The Committee on Standard Specifications for Wrought Iron Pipe (A. A. Reimer, chairman) reported much work of investigation in progress. Two members are studying the chemical and electrical phases of wrought iron pipe; one is trying to find a simple method of distinguishing between wrought iron and steel pipe; another studying coatings.

The Committee on Water Consumption (by J. N. Chester) submitted four blank forms for reporting consumption, three being simplifications of the standard, designed for smaller cities and different conditions of metering, etc.

The Committee on Standard Specifications for Cast Iron Pipe (by Leonard Metcalf) reported that there is a prospect of united action with the New England Water Works Association, the American Association for Testing Materials, the American Society of Mechanical Engineer and the Water Steam & Hot Water Filters' Association, in conjunction with the manufacturers. The committee hopes to make some needed tests to aid it in its work.

The Committee on Tabulation of Rates and Other Data (F. C. Jordan, chairman) reported that it had secured and tabulated data from 437 works and would have its report in the hands of the printer within a month. The report will be in pamphlet form. Average water rates are about $18 per family on the flat schedule and 23c. maximum and 9c. minimum by meter. Valuable data on electrolysis will be included in the report.

Progress reports were made by a number of other standing committees. Dabney H. Maury, for the Committee on Electrolysis, reported that the sommittee sees no reason for changing its report of 13 years ago. Allen Hazen, as a member of the Committee on Permanent

Headquarters said that in his opinion the best location would be in the Engineering Societies Building, New York City. To maintain quarters there, with a secretary on duty, would necessitate a doubling of the membership dues ($5 to $10), which he recommended for consideration. John W. Alvord reported that the Association has been incorporated.

Proposed Chemical and Bacteriological Section

Acting under the new constitution, 15 members took steps to formulate such a section. It is expected that the number will speedily be brought up to the requisite 30. W. F. Montfort, chemist of Water Department, St. Louis, Mo., was elected as temporary chairman and John A. Kienle, of New York City, as secretary. These, with D. D. Jackson, New York City, C. Arthur Brown, Lorain, Ohio, and Prof. Edward Bartow, Urbana, Ill., will serve as a committee on organization.

New Officers and Next Meeting Place

The election of the officers provided for under the new constitution was conducted in accordance with the old methods this year. The results were: President, R. J. Thomas, Lowell, Mass.; Vice-President, Geo. G. Earl, New Orleans, La.; Treasurer, James M. Caird, Troy, N. Y.; Trustees, Theo. A. Leisen, Louisville, Ky., and Chas. R. Henderson, Davenport, Iowa, for three years; Leonard Metcalf, Boston, Mass., and Edward Bartow, Champaign, Ill., for two years; N. S. Hill, Jr., of New York City, and W. R. Young, of Minneapolis, Minn., for one year.

After much campaigning for the next meeting place, Philadelphia was chosen by a clear majority on the first ballot, the chief rival cities being Cincinnati, Erie, Penn., Richmond, Va., and Atlantic City, N. J.

Annual Meeting of the Society for the Promotion of Engineering Education

The 21st annual meeting of the Society for the Promotion of Engineering Education was held at Minneapolis, June 24 to 26. The attendance was fair, the program full and the interest well maintained. One session was held jointly with the American Water Works Association. Parallel sessions were held one afternoon, dealing with (1) Shop Work, Drawing and Coöperative Instruction and (2) Highway Engineering Education. The regular meetings were in the new engineering building of the University of Minnesota and luncheon was taken daily at the Campus Club. A dinner, a reception and a trip to and upon Lake Minnetonka were features of the meeting.

Hydraulic Engineering Education

At the joint evening session with the American Water Works Association an illustrated lecture on Masonry Dams, by Edward Wegman, was followed by papers and a general discussion on Hydraulic Engineering Education. The first of these papers was by Prof. D. W. Mead. Education, he said, is not so much a matter of acquiring knowledge as gaining the power of acquisition. This is particularly true of engineering education. Fundamental principles should be mastered, some knowledge of their application gained as well as some knowledge of human nature, the power of forming judgment and a correct ethical attitude. Undue specialization is dangerous.

Most engineering courses have been well worked out but a weakness of instruction in hydraulic engineering is a lack of proper attention to hydrology. This was shown by the recent floods.

The studies to be covered in an engineering course are so numerous that only outlines of the subject can be given. Thus, water-supply and water-works has 150 to 180 hours, or 15 to 18 days, which is no more than the practicing engineer often gives to a single water-works problem. This illustrates the importance of learning how to study. Professional or special subjects should be deferred until postgraduate courses are taken up privately and attention concentrated on the fundamentals of hydrology. Too often mere facts and figures are given the student, uncorrelated with principles. A limited but systematic course is needed to show the dangers which arise from inadequate knowledge.

The second paper was by Prof. O. L. Waller. Among other things he suggested summer vacation work for students, both to gain practical experience and to show the boys whether or not they were really cut out for engineers. In the Northwest arrangements are being made with practicing engineers to give students work and the students receive credit in course for such work. The amount of the credit is determined in part by questioning the student and in part by questioning the employers.

In a written discussion J. W. Ledoux suggested that the hydraulic engineer should be well grounded in English, mathematics and some of the great laws of natural science, particularly the law of gravitation. A correspondence school course has the advantage of giving instruction in principles while practical work is being carried on.

Prof. Sackett stated that as soon as instruction goes beyond fundamentals it begins to be empirical. He called attention to variations in hydraulic problems due to variations in local conditions in different parts of the country. He urged that some instruction in finance be given, and finally stood up for the average college boy, who he thought had been maligned in the preceding discussion. John W. Alvord said he was glad to see that Prof. Sackett was optimistic about the engineering graduate. Engineers who are using college graduates are not looking for prodigies but rather for plodders, who attain through persistent effort.

Highway Engineering

A dozen pithy papers on opportunities for and education of highway engineers were presented during a short session, with time left for subsequent discussion. Among the "opportunities" set forth were those in state and municipal departments, and in contracting and commercial companies.

Dr. E. S. Whitin presented the humane element in highway construction work, with special reference to the fact that laborers on highway work are often human misfits, including convicts. Prof. Ira O. Baker took up essentials of instruction regarding dirt and gravel roadways, laying special stress upon drainage (by tiles) and the special need for instruction in maintenance. Geo. W. Cooley, state highway engineer of Minnesota, urged that instruction regarding soils is a matter of great importance to all prospective civil engineers. Of eight col-

lege catalogs examined, three (Yale, Columbia and Illinois) show courses in the geology of soils.

A plea for the study of the financial problems of highways as a part of the course in economics, was made by Prof. Geo. R. Chatburn. At present the economics of transportation has to do chiefly with railways rather than highways. Laboratory work was presented by Prof. F. H. Eno; instruction in the chemistry of bituminous materials by Prevost Hubbard and instruction in highway surveying by Henry Drowne. The latter urged that half the time now given to railway surveying in civil engineering courses be devoted to highway surveys instead, taking a stretch of unimproved highway for the purpose.

In the general discussion one speaker called attention to the recent rapid increase in state highway work, which is outrunning the number of men available. Prof. F. E. Turneaure, who presided over the session, stated that the demand for highway engineers just mentioned illustrates the sudden pressure put upon the technical schools at times. At present there is not only a lack of competent highway engineers but of men competent to teach highway engineering. The discussion ended when another speaker expressed the belief that a good civil engineer ought to be able to build good roads.

Other Papers and Discussions

A variety of other subjects were on the program, ranging from "Academic Efficiency" and the "Science of Education" to "The Units of Force" and "Thesis Directions for Students." A number of the papers read were printed in the June "Bulletin of the Society." There was also a group of committee reports on "Improvement in Laboratory Instruction," dealing with civil, electrical, mechanical and mining engineering.

New Officers

Prof. Gardner Chace Anthony, Dean of Engineering of Tufts College, was elected President for the ensuing year. Mr. H. H. Norris, 239 W. Thirty-ninth St., New York City, is Secretary, and W. O. Wiley, of New York, City, is Treasurer.

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A Boy Started a Locomotive, which was standing in the New York Central R.R. roundhouse at Buffalo, N. Y., on June 17. He opened the throttle and as the engine started forward he jumped. It ran through the yard at a high rate of speed and after covering three-quarters of a mile it crashed head on into an approaching freight train, killing the engineer and the fireman of the freight engine.

The Cause of the Explosion of a 3-in. Coast Defense Gun, on May 22, at Fort Moultrie, near Charleston, S. C., was the point of the firing pin striking the cartridge before the breech block was locked, according to a report by the Board of Inquiry which investigated the explosion. It was this explosion which caused the death of Capt. Guy B. E. Hanna and two privates, while nine privates were wounded (reported in our issue of May 29, 1912).

The Locomotive Engine Driver, who caused the rear collision, near Corning, N. Y., on the Delaware, Lackawanna & Western R.R., on the morning of July 4, 1912, was acquitted on the indictment for manslaughter in the second degree by a jury at Hornell, N. Y., June 19.

In his defense, the engineer stated that there was not enough water in the locomotive boiler, and he, therefore, attempted to prime the other injector, but found that the rod leading from the cab to this injector could not be operated, because as he had previously reported, the cab was loose. He now started the first injector, which responded. By the time the latter injector was working again, the danger signal was in sight; as was also the rear end of the train ahead about 100 ft. away. He closed the throttle and applied the air brake, but too late to prevent the collision. He also claimed that due to the fog on that morning the signals along the line were indistinct. (See "Eng. News," July 25, 1912.)

Spreading Rails sent two immigrant cars into the Ottawa River, three miles east of Ottawa, Can., on June 25. Eight colonist passengers were killed.

A Heavy Premature Blast, on June 25, at No. 2 construction camp of the Canadian Pacific Ry., eleven miles west of Parham, Ont., killed ten Italians. About 30 men have been killed, within a radius of 25 mi. in this district, in railway construction during the past 18 months.

An Explosion Wrecked the Plant of the Husted Milling & Elevating Co., at Buffalo, N. Y., on June 24. The accident, it is believed, was the result of the combustion of accumulated grain dust. The entire north side of the big structure was blown out. Of the 172 persons who were in the building at the time of the explosion, 18 are known to be dead, many are missing and many others are in the hospital. The explosion was followed by a destructive fire.

An Aëroplane Crossed the Baltic Sea from Reval to Stockholm, in four hours on June 25, under the direction of Marcel G. Brindejonc des Moulinais. This flight represents the longest journey over open water made by an aëroplane. The Baltic at the point crossed by the aviator is approximately 250 m. wide. The previous record was established by Garros last fall, when he flew across the Mediterranean, from Tunis to Sicily, a distance of about 175 mi.

A 200-Ton Fuel-Oil Tank Exploded, June 27, on the 6000-ton steel tank-steamship "Mohawk," of the Standard Oil Co., anchored off Tompkinsville, S. I. The oil had all been pumped out; and it is thought that the accident was caused by a lighted candle, carried below by a machinist's helper, in search of a washer, igniting the gas. Of the more than 50 men aboard, five are known to have been killed, and six injured.

A Defective Rail on the Alabama Great Southern R.R. caused the derailment, at Collinsville, Ala., on June 20, of a freight train drawing 17 cars loaded with iron ore. According to press dispatches the engineer of the freight train stated that he was able to see the broken rail several car lengths ahead. It is further reported that the locomotive and several cars passed over the defective rail before it broke down. A northbound limited train was due at that point within two hours.

A Wreck Occurred at the intersection of the New York & New Haven R.R. and the Central New England Ry., near Canaan, Conn., June 23. A combination passenger and baggage coach, containing eleven passengers, was standing at the Canaan station, waiting to be coupled to a New Haven milk train. As the latter backed down to the station, it struck this car with sufficient force to send it onto he Cenral New Englang crossover. At the same moment, the rear of a backing freight train, which had reached the intersection, struck the passenger car, smashing the end, and overturning it. Nine persons were injured.

A Bill for Flood Protection, stream regulation and swamp reclamation under the control of the Federal Government is being drafted by the National Drainage Congress in coöperation with government officers. The Secretary of the Interior has delegated to this work the following: F. H. Newell, Director of the U. S. Reclamation Service; George O. Smith, Director of the U. S. Geological Survey, and Brig.-Gen. W. H. Marshall, U. S. A. The Secretary of Agriculture has designated the following as representatives of his department: A. J. Henry, of the U. S. Weather Bureau; Raphael Zon, of the Forest Service, and S. H. McCrory, of the Office of Experiment Stations.

PERSONALS

Dr. Alexander Graham Bell, Past-President, Am. Inst. E. E., received the degree of Doctor of Laws from Dartmouth College, on June 25.

Com. Victor Blue has been appointed Chief of the Bureau of Navigation, Washington, D. C. He was graduated from Annapolis in 1887, and has since been, almost continuously, on active sea duty.

Mr. C. J. Rist, formerly Division Engineer of the Erie R.R., at Huntington, Ind., has been appointed Assistant Engineer Maintenance-of-way of the Pere Marquette R.R., with office at Detroit, Mich.

Mr. John A. Bensel, Past-President, Am. Soc. C. E., State Engineer of New York, was given a banquet, June 26, in

Brooklyn, N. Y., in celebration of the location of the barge canal terminal in that city.

Mr. J. F. Healy, M. Am. Soc. C. E., has opened a consulting mining engineering office in Charleston, W. Va. He will investigate and report upon coal lands. Mr. Healy formerly was General Manager of the Operating Department of the Davis Colliery Co., Elkins, W. Va., for ten years.

Mr. George Westinghouse, Past-President, Am. Soc. M. E., was awarded the Grashoeff gold medal of the Society of German Engineers, at the annual meeting of the society, at Leipzig, on June 23. The honor is accorded annually to a man who has done preëminent work in the field of engineering.

Mr. John H. Tinker, acting Superintendent of Motive power of the Chicago & Eastern Illinois R.R., at Danville, Ill., has been promoted to be Superintendent of Motive Power and Machinery, with headquarters at Danville. He began railway work in July, 1881, as machinist apprentice with the Pennsylvania R.R.

Mr. Albert Nuttall, formerly Erection Superintendent with the Structural Steel Co., and for the last two years Superintendent of Construction for Canada, of the Cleveland Bridge Co., has been appointed Superintendent of Erection, Bridge Department of Canada Foundry Co., Ltd., with headquarters at Toronto.

Mr. William Stanley, of Great Barrington, Mass., an electrical inventor and engineer, was awarded the Edison Medal for meritorious achievement in electricity, by the American Institute of Electrical Engineers, at the Cooperstown convention of the society, June 26. Mr. Stanley is well known as a pioneer in the electric field, especially for his work in connection with the alternating-current system.

A. E. Kastl, M. Am. Soc. C. E., Special Deputy State Engineer in charge of the New York State Barge Canal, was awarded the honorary degree of Master of Engineering by the University of Michigan, on June 26, 1913. Mr. Kastl was graduated from the university in 1885 as Bachelor of Science in Civil Engineering, and in 1901 received the degree of Civil Engineer on account of advanced studies and professional attainments.

Mr. F. L. Guy has been appointed Division Engineer of the Eastern Division of the Atchison, Topeka & Santa Fé Ry., at Emporia, Kan., in place of Mr. M. C. Blanchard. Mr. H. J. Moore has been appointed Division Engineer of the Oklahoma division at Arkansas City, Kan., to succeed Mr. Guy. Mr. O. West has been appointed Acting Roadmaster of the Western division, with office at Dodge City, Kan., succeeding Mr. W. E. Bohl. Mr. E. B. Dehart has been appointed Roadmaster of the Colorado division, with headquarters at Pueblo, Colo., in place of Mr. B. A. West.

Dr. Emory R. Johnson, Professor of transportation and commerce at the University of Pennsylvania, was awarded the honorary degree of Doctor of Science at the recent commencement of the university. Dr. Johnson is an alumus of the University of Wisconsin, class of 1888, and received a Ph. D. degree at the University of Pennsylvania in 1893. He is the author of several books on transportation and of a recent voluminous report on the probable traffic through the Panama Canal and a proposed system of tolls.

Mr. Wm. J. Barney, Assoc. Am. Soc. C. E., has resigned as Second Deputy Commissioner of Docks and Ferries, New York City, to accept, on July 1, the position of Consulting Engineer with the General Contracting & Engineering Co., New York City. Mr. Barney will specialize in port and terminal planning and in the dock engineering and pier construction on which this company is engaged. He was a member of the Board of Consulting Engineers to the Commission of of Public Docks, Portland, Ore., and is, at present, in a similar capacity for the Port Saguenay development in Canada.

Mr. Jerome C. Hunsaker, selected by the Massachusetts Institute of Technology, for the work of accumulating information bearing upon the new course in aërodynamics, to be developed by the Institute, is from Saginaw, Mich., and a graduate of the Saginaw High School, and of the U. S. Naval Academy, '08, where he was No. 1 in a class that on entering numbered 309. He was on sea duty for a year, was with the U. S. S.S. "Carolina," on the west coast, and then, in accordance with the law concerning naval constructors, studied three years at the Institute of Technology, graduating in 1912. His investigations which were made with Naval Constructor R. T. Hansen, were toward determining rudder pressures. This had not been undertaken in a scientific way at high speeds and the results have been published by the Society of Naval Architects and Marine Engineers. Since leaving the Institute, Mr. Hunsaker has been Assistant Shop Superintendent at the Boston Navy Yard. One of his contributions in aërodynamics is his translation of Eiffel's "Resistance of the Air and Aviation," which is in press.

OBITUARY

David R. DeMuth, aged 28, a civil engineer, employed by the Montana Reservoir & Irrigation Co., at the Hepgen dam, on the Madison River, was drowned on June 15. Mr. DeMuth was graduated from the Montana State College in 1909.

Capt. A. J. Whitney, a veteran river contractor, died at Villisca, Iowa, on June 5, from a stroke of paralysis. Captain Whitney learned the machinist trade at New Haven, Conn., and served as machinist, locomotive engineer, and shop superintendent from 1849 to 1870. In 1870, George Williams, of Keokuk, Iowa, Superintendent of the Des Moines Valley R.R., engaged him as Superintendent of Construction, in charge of about 600 men. In 1871, he took charge of the improvement work of the Rock Island Rapids, building the cofferdams for the rock excavation work in that swiftly running current. He was connected with the Chicago, Burlington & Quincy R.R. when Aurora, Ill., was its Western terminal; on the Burlington & Missouri River R.R. when Mount Pleasant, Iowa, was its Western Terminal; and on the Des Moines Valley R.R. during its early history.

ENGINEERING SOCIETIES

COMING MEETINGS

OHIO ELECTRIC LIGHT ASSOCIATION.
July 15-18. Annual convention at Cedar Point, Ohio. Secy., D. L. Gaskill, Greenville, Ohio.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
July 17-19. Annual summer meeting at Buffalo, N. Y. Secy., E. A. Scott, 29 W. 39th St., New York City.

INTERNATIONAL GEOLOGICAL CONGRESS.
Aug. 7-14. Twelfth annual session at Toronto, Ont. General Secy., R. W. Brock, Director of Geological Survey of Canada, Ottawa, Ont.

THE TRAVELING ENGINEERS' ASSOCIATION.
Aug. 12-16. Annual convention at Chicago, Ill. Secy., W. O. Thompson, New York Central Car Shops, East Buffalo, N. Y.

INTERNATIONAL ASSOCIATION OF FIRE ENGINEERS.
Sept. 1-6. Annual convention at New York City. Secy., Jas. McFall, Roanoke, Va.

NEW ENGLAND WATER-WORKS ASSOCIATION.
Sept. 10-12. Annual convention at Philadelphia, Penn. Secy., Willard Kent, Narragansett Pier, R. I.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Sept. 9-13. Annual meeting at Colorado Springs, Colo. Secy., S. M. Guma, 755 Boyleston St., Boston.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.
Sept. 9-12. Annual convention at Ottawa, Ont. Secy., A. P. Dane, Reading, Mass.

American Gas Institute—The annual meeting will be held at Richmond, Va., Oct. 15-17.

Railway Signal Association—The annual meeting will be held at the Hotel Hermitage, Nashville, Tenn., Oct. 14-16.

American Electric Railway Association—The annual convention will be held at Atlantic City, N. J., Oct. 13-17.

National Conservation Congress—The Executive Committee announces that the Fifth National Conservation Congress will meet in Washington, D. C., Nov. 18-20, 1913.

Philadelphia Section of the Illuminating Engineering Society—At the meeting, on June 20, the following officers were elected for the ensuing year: Chairman, Prof. G. A. Hoadley; Secretary, L. B. Eichengreen.

Compressed Gas Manufacturers Association—This association was organized on Mar. 21. Its objects are to protect the property rights of its members in their cylinders out with the trade; to secure proper recognition of its members' demands before the Interstate Commerce Commission in the matter of freight rates and clasification; to effect a standardization of cylinders and their connections so far as is practicable; to obtain uniform, safe and reasonable regulations, local, state and interstate; to report lost cylinders to its members by a system of mutual coöperation; to institute careful investigation of all accidents assigning the proper causes, for the purpose of minimizing such accidents; to establish a commercial bureau to extend the gas industry by ascertaining the new fields in which gases might be used, to foster friendly intercourse between members of the association and promote generally their welfare.

The officers are: President: Dr. Hugo Lieber; Secretary-Treasurer, John J. O'Rorke, 25 Madison Ave., New York City.